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Proceedings of the Second Annual Meeting of the Pacific Slope Branch of the American Association of Economic Entomologists

The second annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held at Stanford University, California, April 5 to 6, 1917. The business was transacted at the first and last meetings, but in the proceedings are all included in the first part.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by Chairman A. W. Morrill at 10.30 a. m., Thursday, April 5, 1917. There were 37 members and visitors present. Of this number the following were members:

Burke, H. E., Los Gatos, Cal.
Coleman, G. A., Berkeley, Cal.
Davidson, W. M., Sacramento, Cal.
Doane, R. W., Stanford University, Cal.
Essig, E. O., Berkeley, Cal.
Foster, S. W., San Francisco, Cal.
Herms, W. B., Berkeley, Cal.
Morrill, A. W., Phoenix, Ariz.
Morris, Earl, San Jose, Cal.
Van Dyke, E. C., Berkeley, Cal.

CHAIRMAN A. W. MORRILL: The meeting will please come to order. May we first have the report of the secretary-treasurer:

REPORT OF TREASURER

EXPENSES SINCE LAST MEETING

Feb. 5, 1917
Affiliation fee to Pacific Division, American Association for the Advancement of Science $5.00

April 2, 1917

Expenses for Stanford meeting:

Stamped envelopes, 1 c. legal size	$0.80
Multigraphing circular letter	1.25
Printing 150 copies application for membership	2.75
Total	$9.80

Examined and found correct.

R. W. DOANE,
H. E. BURKE,
Auditors.

CHAIRMAN A. W. MORRILL: There are a number of committees to be appointed as follows:

RESOLUTIONS COMMITTEE

H. J. Quayle G. P. Weldon
E. O. Essig

MEMBERSHIP COMMITTEE

H. S. Smith....1 year
H. J. Quayle....2 years
H. E. Burke....3 years

AUDITING COMMITTEE

H. E. Burke R. W. Doane

NOMINATING COMMITTEE

H. E. Burke R. W. Doane

The last part of the business meeting was called by Chairman A. W. Morrill, Friday, April 6, 4.30 p. m.

CHAIRMAN A. W. MORRILL: At the urgent request of A. L. Barrows, Secretary of the Pacific Division of the American Association for the Advancement of Science, for the appointment of a delegate to act on the affiliation committee, especially to consider means of assistance in the national crisis, which is to meet at 5 p. m., R. W. Doane has been appointed to serve for the ensuing year.

It was proposed by the secretary that other entomological societies of the Pacific Slope be invited to participate in the meetings of the Pacific Slope Branch in the future. Such meetings would be of mutual benefit and would have a tendency to stimulate work in all. This proposal was made in the form of a motion by H. E. Burke and seconded by R. W. Doane. Carried by the house.

CHAIRMAN A. W. MORRILL: We will now have the report of the nominating committee:

REPORT OF THE NOMINATING COMMITTEE

For chairman.....G. P. Weldon
For vice-chairman.....H. J. Quayle
For secretary-treasurer.....E. O. Essig

H. E. Burke,
R. W. Doane,
Nominating Committee.

REPORT OF THE MEMBERSHIP COMMITTEE

The membership committee approved of the following applications for membership with the recommendation that they be submitted to the regular membership committee of the association for final action:

Day, L. H., Hollister, Cal.
Ferris, G. F., Stanford University, Cal.
Freeborn, Stanley B., Berkeley, Cal.
Gray, Geo. P., Berkeley, Cal.
Henderson, W. W., Logan, Utah.
Penny, Donald D., Berkeley, Cal.
Severin, Henry H. P., Berkeley, Cal.
Vickery, R. K., Saratoga, Cal.
Wells, R. W., Bozeman, Mont.
Woodworth, H. E., Berkeley, Cal.
Herbert, F. B., Los Gatos, Cal.

By vote of the house the report of the nominating committee was accepted and the secretary instructed to cast the ballot for the election of the officers named.

The report of the membership committee was accepted with the instructions that the applications be referred to the general committee as proposed.

Upon motion of the house the meeting was adjourned.

E. O. Essig,
Secretary.

PART II. PAPERS AND DISCUSSIONS

It was impossible to report the discussions following the papers as no official reporter was secured for this purpose and rather than give a partial account, this part of the meetings has been omitted.

Chairman A. W. Morrill: The first paper on the program is one prepared by myself and is as follows:

COTTON PESTS IN THE ARID AND SEMI-ARID SOUTHWEST

By A. W. Morrill, *Phoenix, Arizona*

During the past few years there has been a notable increase in cotton production in the arid and semi-arid Southwest. This increase is of interest inasmuch as it has tended to offset the losses morf the Mexican boll weevil in the humid region of the cotton belt. It is of further interest since in Arizona and to a small extent also

in California, a kind of cotton, Egyptian, is being produced for which other sections of the country are not adapted and for which there will be an increasing demand as the Mexican boll weevil damage to the Sea Island cotton industry in the East increases.

The growth of the cotton industry in west Texas is shown by a comparison of a series of recent years with an earlier series. For the seasons of 1899, 1900, 1901 and 1902 the west Texas counties lying west of the ninety-eighth meridian, produced on the average 17 per cent of the total crop of the state whereas for the seasons 1911, 1912, 1913 and 1914 the same section produced on the average about 27 per cent of the state's crop.

In the extreme arid portion of the southwestern United States cotton has become firmly established as an important crop within the short space of seven years. In 1909 the total cotton production of the states of California, Arizona and New Mexico amounted to only 390 bales whereas in 1916 the production had reached a total of over 52,000 bales in these states. The New Mexico acreage is virtually an extension of the west Texas or semi-arid cotton-growing region and is of not as much interest as presenting new problems in economic entomology as are cotton-growing districts of Arizona and California. These are located in the most arid section of the United States where the annual rainfall averages less than eight inches. With its important relation to the dairy and beef feeding industries, cotton growing has become one of the corner-stones of agriculture in this part of the arid Southwest. Its direct returns to this region amounted to about six million dollars for the past season and it is expected that it will become a twenty million dollar industry within a few years.

The development of this new industry as briefly outlined has developed also the need for special protection against the introduction of pests and for a practical knowledge of other cotton pests which already exist in the arid Southwest. The existence in parts of southern Arizona of a native species of wild cotton plant (*Thurberia thespesiodes*) with its native insect enemies introduces an element of possible danger and a factor which is highly interesting from the scientific standpoint.

Cotton growing in [illegible] arid and semi-arid Southwest is confined to the Lower Sonoran [illegible]a of the Lower Austral life zone and to the Tropical region on the [illegible]ower Colorado. Passing westward from the ninety-eighth meridian in Texas, a marked difference in the pests of cotton is soon noted. Certain ones are found in abundance which do not occur or are rarely found in the humid region, others commonly found in both regions become more injurious to cotton and still others become less so. Further differences are noted between different localities just as local differences occur in the humid cotton belt.

In this paper no attempt is made to name all of the different species of insects which have been found on cotton or in cotton fields. There are dozens of insects, especially among the Hemiptera, which are commonly found on the cotton plant and which are recognized as capable of becoming injurious but which are not known to have done noticeable damage to cotton so far. In the future some of these species will increase injuriously from time to time, usually in restricted localities, while others which have already demonstrated their injuriousness will from time to time become temporarily of little or no consequence as cotton pests.

HEMIPTERA

Up to the present time the insect order Hemiptera has provided the largest number of the more destructive cotton pests found through the section under consideration and in Arizona and California, at least, these insects promise to become the most troublesome group judged from their combined capacity for damage to cotton.

In west Texas the lygus bug (*Chlorochroa ligata*) (12 and 13) is the most prominent plant bug having a history as a cotton pest. This insect has been taken at various points in southern Arizona. It was found feeding on the bolls of Thurberia in the Santa Rita Mountains but so far as known has not been taken on cultivated cotton in Arizona or California. It occurs in the Salt River Valley, a single specimen having been taken near Mesa on alfalfa.

The brown cotton bug (*Euschistus servus*) of the humid cotton-growing states (13) is represented in Arizona cotton fields by one of the same genus (*E. impictiventris*) which up to this time has proven to be our most common pentatomid cotton pest. This has been of common occurrence on cotton in the Salt River Valley and in the lower Colorado Valley near Yuma but like its eastern relative its injuriousness is due to its general occurrence in small numbers in almost all cotton fields rather than to fluctuating abundance and occasionally severe outbreaks.

The Arizona cotton stainer (*Dysdercus albidiventris*) has been the cause of the most severe local insect injury to cotton so far observed in the Salt River Valley (17). It has also been found on cotton in the Gila Valley near Sacaton but has not been reported from the cotton-growing district of southwestern Arizona and southeastern California. Another Pyrrhocorid bug, *Euryopthalmus* (=*Largus*) *succinctus*, is common and widely distributed in the arid Southwest but there is only one record of its occurring on cotton in sufficient numbers to do noticeable injury. This observation (13) was made in western Texas. In the extreme arid Southwest it has been taken on cotton near Bard, California; Florence, Arizona; and Mesa, Arizona.

The western leaf-footed plant bug (*Leptoglossus zonatus*) which has been noted as an enemy of cotton in northern Mexico (13) is very abundant in parts of southern Arizona and has been taken on cotton in the Salt River Valley and at Bard, California. Its favorite food is the fruit of the pomegranate but it should be regarded as a cotton pest owing to its known capability for damaging the bolls and occasional injury to cotton may be expected from this species, as is done in the humid cotton sections by its eastern relatives (*L. phyllopus* and *L. oppositus*).

The tarnished plant bug (*Lygus pratensis* and its varieties)[1] was observed by Mr. W. D. Pierce of the Bureau of Entomology as injurious to cotton squares in the Imperial Valley in California in 1913 and the same species has since proven quite destructive locally (16) in the Salt River Valley in Arizona. Although this insect occurs throughout the eastern cotton belt it does not appear to have attracted attention as a cotton pest except in Arizona and California.

ORTHOPTERA

Four or five species of Orthoptera have placed this insect order ahead of the Lepidoptera and of about equal grade with the Hemiptera in the total amount of damage to cotton in the arid Southwest. The most generally destructive species is the differential grasshopper (*Melanoplus differentialis*) well known also as a cotton pest in the humid sections (15). In the Salt River Valley ranking next to the differential grasshopper are two species of the genus Schistocerca (*S. vega* and *S. shoshone*) which are common in cotton fields and in one locality in 1913 proved exceedingly destructive (14). During 1916 a species of cricket was one of the most destructive cotton pests in the Imperial Valley, necessitating the replanting of several hundred acres, according to Mr. E. A. McGregor of the U. S. Bureau of Entomology, who, in connection with his cotton insect investigations, is giving special attention to this pest. Grasshoppers are also reported as among the leading Imperial Valley cotton pests.

LEPIDOPTERA

The arid Southwest has an extremely formidable list of lepidopterous enemies of cotton, although the combined damage so far has not been very extensive. This list includes the cotton bollworm

[1]The late O. Heidemann identified several lots of this material as "*Lygus pratensis*," "*Lygus pratensis* var. *lineolarius*," "*Lygus pratensis* var." and "*Lygus* sp. near *pratensis*." Evidently *Lygus pratensis* is a variable species and it will require special study to properly distinguish the southwestern forms as subspecies or to prove that they are merely color varieties.

(*Heliothis obsoleta*), the cotton leafworm (*Alabama argillacea*), the salt marsh caterpillar (*Estigmene acræa*), the cotton boll cutworm (*Prodenia ornithogalli*), the fall webworm (*Hyphantria cunea*), the western army cutworm (*Chorizagrotis agrestis*) the cotton leaf perforator (*Bucculatrix thurberiella*) and an undetermined bollworm which attacks the bolls of the Arizona wild cotton.

In their consideration of the distribution and destructiveness of the cotton bollworm in relation to life zones, Quaintance and Brues (21) say: "In Texas, from about the ninety-eighth meridian westward, the bollworm rapidly becomes of less and less importance along with the diminishing rainfall." In Arizona and California cotton-growing districts the bollworm attacks corn as extensively as it does in the humid eastern cotton states but for some as yet unexplained reason the insect has thus far done very little damage to cotton in these sections. It is noteworthy, however, that in the arid Laguna district in Mexico, about 500 miles south of Phoenix at an elevation of 3,700 feet, the cotton bollworm has during certain seasons caused heavy losses.

The cotton leafworm was found on Thurberia plants in the mountain canyons of southeastern Arizona, and on cultivated cotton in the Salt River Valley and near Tucson in the summer of 1913. The next season it was found in Graham County in eastern Arizona where cotton was being tried out on a small scale about 75 miles from any other plantings. The insect has not been found near Yuma although carefully searched for and Mr. McGregor of the U. S. Bureau of Entomology informs me that he failed to find a single specimen of the leafworm in the Imperial Valley in 1916. In one instance the writer observed a Salt River Valley Egyptian cotton field partially defoliated by the leafworm but this was late in the season and apparently no material damage was done to the crop.

The salt marsh caterpillar is a common pest in Salt River Valley cotton fields but there is no record of its injury to cotton elsewhere in the arid Southwest. The injury from this insect is sporadic and the occasional local outbreaks which have been noted have apparently been due to the insects having completely consumed the supply of a preferred food plant, a common weed known as the yellow-flowered ground cherry (*Physalis angulata* var. *linkiana*).

The cotton boll cutworm and the fall webworm can only be recorded as among those cotton pests present in Salt River Valley fields. The actual damage noted in any case has been inappreciable.

Cutworms did considerable damage in the spring of 1916 in one locality in the Salt River Valley, necessitating the replanting of several acres where the use of poisoned bran was not resorted to in time. Attempts to breed out the insects were unsuccessful but it is be-

lieved that all specimens of the worms found were "western army cutworms."

The cotton leaf perforator is a cotton pest which is evidently native of the arid Southwest. It was originally found on the Arizona wild cotton but has since appeared on cultivated cotton in the Salt River Valley (15) and the Imperial Valley (11), strongly indicating that the insect has other native food plants than the Thurberia. If, however, the Arizona wild cotton is the insect's only native food plant and the Salt River Valley infestation is traceable to this source, the insect may have been carried to the Imperial Valley by means of cotton seed shipments. Owing to the activity of parasites this insect is not considered a very serious cotton pest although in 1914 it was very abundant in the Salt River Valley and in 1916 in the Imperial Valley.

The unidentified Thurberia or wild cotton bollworm is considered by the writer to be more widespread and destructive to its food plant than is the wild cotton weevil. The full grown larva is robust and about an inch in length and the adult is therefore a moth which we may presume to be fairly capable as a flier.[1] It is to be expected that this insect will be found in the cotton fields of the Casa Grande or Salt River Valley in Arizona within a few years. In captivity the worms feed as readily on Egyptian cotton bolls and squares as upon the Thurberia cotton and the importance of the insect as a pest will depend on its adaptability to conditions in irrigated cotton fields at elevations much lower than their present known limits.

Coleoptera

While the Mexican cotton boll weevil (*Anthonomus grandis*) has made some progress into the western section of Texas it has not thus far been able to fully adapt itself to semiarid conditions (8, 9, 10, 18). This does not in the writer's opinion preclude the possibility of this insect quickly adapting itself and proving injurious if introduced into the extreme arid sections where cotton is grown entirely under irrigation.

The Thurberia or Arizona wild cotton (*A. grandis thurberiæ*) weevil which is found only in and near certain mountain ranges in southeastern Arizona is properly regarded with apprehension. It is a form of the cotton boll weevil which is thoroughly adapted to arid conditions but at present it is harmless, and may remain so indefinitely. In the event that it appears at any time in the future in the cotton fields of the Casa Grande Valley—a new district where cotton will be grown

[1] Attempts to rear the adult have so far been unsuccessful. Dr. H. G. Dyar, who examined specimens of the larvæ, noted that they resembled those of *Sacadodes pyralis*, a worm which attacks cotton bolls in Trinidad.

this season, located about fifty miles from the insects' present range—the suspension of cotton growing in the district for one season would offer a practical means of complete eradication. The Arizona cotton fields have been closely inspected in the past in order that this and other cotton pests may be promptly detected in the event of their introduction. Proportionally more attention will be given to the new cotton district mentioned which lies between the Salt River Valley and the Santa Catalina Mountains. Even with its proximity to the cotton fields of Arizona, the wild cotton weevil is insignificant in comparison with the pink bollworm as a menace to the cotton industry of the arid Southwest. This latter pest will be mentioned again. The relation of elevation to the future distribution of the weevil in the arid Southwest is an interesting subject for conjectures but not a safe matter to investigate. The insect has been found at elevations from about 2,750 to 7,000 feet but is reported by Coad (3) as more abundant on plants growing at elevations from 3,500 to 5,000 feet. The cotton plantings in the Casa Grande Valley are all below 1,500 feet elevation and in the Salt River Valley below 1,300 feet. The discontinuance of cotton growing near Tucson, permanently it is hoped, has removed the most important element of danger, which consisted practically of an intermediate step between the present habitat of the weevil and the important cotton-growing districts of lower elevations.

Homoptera

The cotton aphis (*Aphis gossypii*) is the only representative of the Homoptera which has so far proven injurious to cotton in the arid Southwest. In the season of 1914 this insect, known in the older cotton states as a cotton pest only on account of occasional injury to very young plants, was notably destructive to cotton throughout the greater part of the growing season in the Yuma and Imperial Valleys (15). While no appreciable injury has so far been reported it is interesting to note that adults of a species of the insect family Aleurodidæ were observed on cotton in the Imperial Valley by Mr. W. D. Pierce in 1913 and a similar observation was made by Mr. Pierce and the writer in the Salt River Valley. The possibility of white flies becoming injurious to cotton occasionally is shown by a statement from Mr. E. A. McGregor of the U. S. Bureau of Entomology, located in the Imperial Valley in cotton insect investigations, who writes concerning them: "They frequently rise in clouds as one brushes through the rows." In the humid cotton belt we have a record by Ashmead of similar abundance of an Aleyrodid (*Asterochiton abutiloneus*) in Mississippi with but slight injury.

Thysanoptera

The only notable injury to cotton in the United States by insects of the order Thysanoptera is that by a western species, the bean thrips (*Heliothrips fasciatus*) in the Imperial Valley (7 and 20). This species occurs in the Salt River and Yuma Valleys and has been noted as injuring beans in the former section but so far has not been found on cotton in Arizona in injurious numbers. However, temporary injury to a few young cotton plants by another species (*Microthrips piercei*) was once noted in the Salt River Valley (14).

Acarina

Two species of mites occur in Arizona which are of interest in a consideration of cotton pests. The common two-spotted mite (*Tetranychus bimaculatus*) is a pest of violets and sometimes of strawberries in the Salt River Valley but there is no record of its occurrence on cotton anywhere in the arid Southwest. From the fact that hot dry weather is favorable for this pest in the East we must regard it as dangerous in its possibilities as a pest of cotton. The second representative of the Acarina referred to above is the wild cotton blister mite (*Eriophyes thurberiæ* Bks.) which is quite destructive to the Thurberia plant and would be an undesirable addition to our list of pests of cultivated cotton if it were to spread from its present habitat. This, so far as known, is limited to certain mountain canyons in southern Arizona.

In a general consideration of cotton pests a more or less arbitrary standard must be set in deciding what species are worthy of mention. As has been stated, it is not the writer's intention to include in this paper a complete list of insects which have been collected on cotton and which are capable of doing damage. Only those concerning which definite observations have been recorded are mentioned herein. In comparison with the humid cotton belt it is interesting to note that to date the arid Southwest has a list of 20 species of insects which can be definitely recognized as pests of cultivated cotton and in addition two species of insects and one mite which are pests of Thurberia or Arizona wild cotton, making a total of 23.

East of the ninety-eighth meridian there are at least 42 insect pests and one mite concerning which we have definite records of appreciable injury to cotton.

The order Lepidoptera leads in both sections, having 18 in the East and eight in the West. The order Hemiptera follows with 11 in the East and six in the West.[1] Four representatives of the order

[1]Including one which is common in the arid Southwest of this country and which is known as a cotton pest from observations in arid northern Mexico, which in a general way belongs to the same cotton zone.

Orthoptera are listed for each section. Of the Coleoptera there are six eastern cotton enemies and two western—counting *Anthonomus grandis* and *A. grandis thurberiæ* as two species. The order Hymenoptera contributes two species to the list of cotton enemies in the East and none in the West, Homoptera two in the East and one in the West, Thysanoptera none in the East and one in the West. Of the Acarina there is one species which has proven injurious to cotton in the East and one in the West—this latter one being confined at present to wild cotton.

Eight species are injurious to cotton in both the humid and arid sections while at least two of the eastern species, the false chinch bug (*Nysius angustatus*) and the two-spotted red spider (*Tetranychus bimaculatus*), are common in some and probably all of the cotton growing localities of the arid Southwest but have not yet proven injurious.

A survey of the insect enemies of cotton is of special interest at this time when the industry is confronted with the most serious menace which has ever appeared on the North American continent. The presence of the pink bollworm (*Gelechia gossypiella*) in the Laguna district of northern Mexico (23) calls for the most vigorous measures for its extermination for the protection of the cotton industry of the United States, whatever difficulties may be involved in a problem of this kind on foreign soil and even if the expense amounts to ten million dollars or to twice this amount. Even the entrance of our country into a great war in the interests of humanity should not blind us to the danger in the existence of this insect at our very doors. There is no single product of the soil which is of as great importance and so indispensable to mankind as cotton and with our past experience with the Mexican boll weevil and the extensive investigation of miscellaneous cotton pests made during the past few years it is now generally acknowledged, East and West, even in new cotton-growing districts, that the continued success of this great industry is more dependent on the exclusion, control and eradication of insect pests than on any other factor.

Literature

(1) Coad, B. R. Relation of the Arizona Wild Cotton Weevil to Cotton Planting in the Arid West. Bul. 233, U. S. D. A., pp. 1–12. May, 1915. A consideration of the subject named based on investigations conducted in 1914.

(2) Coad, B. R. Recent Studies of the Cotton Boll Weevil. Bul. 231, U. S. D. A., pp. 1–34. August, 1915. This includes a report of investigations of biology of *Anthonomus grandis thurberiæ* at Victoria, Texas, in 1913.

(3) Coad, B. R. Studies on the Biology of the Arizona Wild Cotton Boll Weevil. Bul. 344, U. S. D. A., pp. 1–23. January, 1916. A detailed report of life-history investigations of *Anthonomus grandis thurberiæ* made in 1914 near

(4) Coad, B. R. and Pierce, W. D. Studies of the Arizona Thurberia Weevil on Cotton in Texas. Proc. Ent. Soc. Wash., vol. XVI, No. 1, pp. 23–27. March, 1914. Studies of biology of *Anthonomus grandis thurberiæ* at Victoria, Texas, in 1913.

(5) Cook, O. F. A Wild Host Plant of the Boll Weevil in Arizona. Science n. s., vol. 27, No. 946, pp. 259–261. February, 1913. This article contains the first record of the occurrence of a weevil attacking *Thurberia thespesiodes* in Arizona.

(6) Cockerell, T. D. A. Some Insect Pests of the Salt River Valley and Remedies for Them. Bul. 32, Ariz. Agr. Exp. Sta., pp. 288–289. Brief mention made of injury of bollworm to corn in Arizona and New Mexico.

(7) Coit, J. E. and Packard, W. E. Imperial Valley Settlers Crop Manual. Bul. 210, Cal. Agr. Exp. Sta., pp. 184, 181 and 240. January, 1911. Injury by bollworm to corn and tomatoes in the Imperial Valley is mentioned in this bulletin but no mention made of injury to cotton. Injury by *Heliothrips fasciatus* to cotton leaves is reported.

(8) Hunter, W. D. The Status of the Cotton Boll Weevil in 1909. Circ. 122, Bur. Ent., U. S. D. A., pp. 1–8. December, 1910. Contains a discussion of effect of semi-arid and arid conditions on Mexican cotton boll weevil.

(9) Hunter, W. D. (Remarks.) Proc. Ent. Soc. Wash., vol. XVI, No. 1, pp. 27–28. March, 1914. A brief discussion of cotton growing in semi-arid and arid sections with reference to *A. grandis* and *A. grandis thurberiæ*.

(10) Hunter, W. D. and Pierce, W. D. The Mexican Cotton Boll Weevil. Bul. 114, Bur. Ent., U. S. D. A., pp. 23–29. February, 1912. Refers to relation of arid and semi-arid conditions on *A. grandis*, an extension of the discussion by Hunter in Circular 122.

(11) McGregor, E. A. *Bucculatrix thurberiella*, A Pest of Cotton in the Imperial Valley. Jour. Econ. Ent., vol. 9, No. 5. October, 1916. Notes on injury by cotton leaf perforator in the Imperial Valley in 1916, also description of stages.

(12) Morrill, A. W. The Mexican Conchuela in Western Texas in 1905. Bul. 64, Part I, Bur. Ent., U. S. D. A., pp. 1–14. April, 1907. A report of observations on an outbreak of this insect (*Chlorochroa ligata*) in extreme west Texas, including reference to its injury to cotton.

(13) Morrill, A. W. Plant Bugs Injurious to Cotton Bolls. Bul. 86, Bur. Ent., U. S. D. A., pp. 24–25, 74, 94. June, 1910. This includes a report of investigations of the conchuela, the grain bug (*C. sayi*) and the bordered plant bug (*Euryopthalmus succinctus*), all three of which had been found injuring cotton only in the semi-arid and arid sections of Texas and in arid sections of Mexico. The occurrence of the leaf-footed plant bug (*Leptoglossus zonatus*) in cotton fields in Durango, Mexico, is also mentioned.

(14) Morrill, A. W. Cotton Pests, Fifth Annual Report, Ariz. Comm. Agr. & Hort., pp. 38–48. December, 1913. A discussion of the bollworm, cotton leafworm, and two grasshopper pests (*Schistocerca vega* and *S. shoshone*) of cotton and their remedies, also of *Anthonomus grandis thurberiæ*, the Thurberia or wild cotton bollworm and the Thurberia blister mite (*Eriophyes sp.*). The following cotton pests are mentioned: cotton boll cutworm (*Prodenia ornithogalli*); the Mexican Conchuela; the grain bug; leaf-footed plant bug (*Leptoglossus zonatus*); the bordered plant bug (*Euryopthalmus succinctus*); the cotton aphis (*Aphis gossipii*) and the cotton red spider (*Tetranychus bimaculatus*). Injury to cotton by *Microthrips piercei* on one occasion is noted.

(15) MORRILL, A. W. Cotton Pests, Sixth Annual Report, Ariz. Comm. Agr. & Hort., pp. 37–46. December, 1914. A discussion of the cotton aphis injury at Yuma in 1914 and relation of *Hippodamia convergens* to its control, of the salt marsh caterpillar, cotton leafworm, cotton bollworm, the differential grasshopper (*Melanoplus differentialis*) and the cotton leaf perforator.

(16) MORRILL, A. W. Cotton Pests, Seventh Annual Report, Ariz. Comm. Agr. & Hort., pp. 41, 43–45. December, 1915. Includes a discussion of a tarnished plant bug (determined as *Lygus* sp. near *pratensis*) with mention of the cotton leaf perforator, the red spider (*Tetranychus bimaculatus*) and the bollworm.

(17) MORRILL, A. W. Cotton Pests, Eighth Annual Report, Ariz. Comm. Agr. & Hort., pp. 45–49. December, 1916. Includes an extended discussion of cotton stainer injury to cotton bolls with special reference to the Arizona cotton stainer (*Dysdercus albidiventris*), also notes concerning the scarcity of the cotton leaf perforator in 1916 evidently as a result of control by parasites and of the occurrence on cotton in southern Arizona in 1916 of the bollworm, pentatomid bugs, cutworms and *Coryzus validus*.

(18) PIERCE, W. D. The Occurrence of a Cotton Boll Weevil in Arizona. Jour. Agr. Research, vol. I, No. 2, pp. 89–98. November, 1913. This includes notes on the occurrence of the Arizona wild cotton weevil in Arizona. This insect is described as *Anthonomus grandis thurberiæ* and distinguished by comparative studies from *A. grandis*.

(19) PIERCE, W. D. and MORRILL, A. W. Notes on the Entomology of the Arizona Wild Cotton. Proc. Ent. Soc. Wash., vol. XVI, No. 1, pp. 14–23. March, 1914. This consists in a report on explorations and observations made by the authors in 1913. Notes are included on the wild cotton boll weevil, the cotton leafworm, the Thurberia bollworm, a blister mite, a Cecidomyid gall maker, a mealy-bug, the cotton leaf perforator of bucculatrix and a lepidopterous leaf folder (*Dichomeris deflecta*). A total of eighty-three different species of insects and mites are mentioned including twenty-five which may be classed as injurious.

(20) RUSSELL, H. M. The Bean Thrips. Bul. 118, Bur. Ent., U. S. D. A., p. 30. October, 1912. This bulletin contains four paragraphs quoted from notes by V. L. Wildermuth concerning injury by the bean thrips (*Heliothrips fasciatus*) to cotton in the Imperial Valley during 1910 and 1911.

(21) QUAINTANCE, A. L. and BRUES, C. T. The Cotton Bollworm. Bul. 50, Bur. Ent., U. S. D. A., pp. 28, 29. 1905. Contains on pages mentioned a brief statement concerning status of the bollworm in the Lower Sonoran area of the lower Austral life zone.

(22) TOWNSEND, C. H. T. The Cotton Square Weevil of Peru and its Bearing on the Boll Weevil Problem of North America. Jour. Econ. Ent., vol. 4, No. 2, pp. 244–248. April, 1911. The writer presents his views in regard to the future development of cotton growing in the arid Southwest with special reference to the supposed immunity of this section to the cotton boll weevil (*Anthonomus grandis*).

(23) ———. Pink Bollworm. Jour. Econ. Ent., vol. X, No. 1, p. 225. A note concerning presence of *Gelechia gossypiella* in northern Mexico.

CHAIRMAN A. W. MORRILL: The next paper on the program will be presented by Dr. H. H. P. Severin.

MEDITERRANEAN FRUIT-FLY (CERATITIS CAPITATA WIED.) BREEDS IN BANANAS

By HENRY H. P. SEVERIN, PH. D.

In an article entitled, "Banana as a Host Fruit of the Mediterranean Fruit-Fly," Back and Pemberton (1, p. 802) "seriously question the statement" made in one of my publications (6, p. 70) that the "fruit-fly was also bred from a half-ripe banana under field conditions." Four scientists have bred the Mediterranean fruit-fly from bananas. Back and Pemberton, however, endeavor to cast doubt upon the results obtained by three of these naturalists. The reader is entitled to the data which I shall quote from scientific journals and correspondence.

My seriously questioned statement, that the "fruit-fly was also bred from a half-ripe banana under field conditions," was published in an article (6) which was read in more expanded form before the American Association of Economic Entomologists. Since the editor of the JOURNAL OF ECONOMIC ENTOMOLOGY, in which this article was published, requested me to give a brief summary of the paper read, the sentence in question was condensed from several statements published in an earlier and more detailed paper (5).

I quote verbatim the statements which were published in my summarized paper (6): "In the last number of the JOURNAL OF ECONOMIC ENTOMOLOGY, V, No. 6, pages 443–451, we published a paper entitled, 'Will the Mediterranean Fruit-Fly (*Ceratitis capitata* Wied.) Breed in Bananas under Artificial and Field Conditions?' There is no question of doubt but that the Mediterranean fruit-fly will occasionally breed in ripe and over-ripe bananas under Hawaiian conditions. The fruit-fly was also bred from a half-ripe banana under field conditions." It is evident that I referred the reader in my summarized paper (6) to the earlier and more detailed paper (5).

I now quote the statements which were published in our earlier and more detailed paper (5, p. 448): "During the mosquito campaign, when the banana trees were cut down in Honolulu, hundreds of bunches of bananas were examined to see if there was any evidence that the pest was breeding in bananas under field conditions. Hundreds of bananas containing maggots were removed from these bunches and placed in jars containing sterilized sand. From these bananas a small number of Mediterranean fruit-flies, numerous specimens of an Anthomyid, *Acritochæta pulvinata* Grims.; two species of Ortalidæ, *Euxesta annonæ* Fabr. and *Notogramma stigma* Fabr., and a number of species of Drosophilidæ were bred. The fruit-flies were bred from but two bananas, one of which when taken from the bunch was

decayed at the flower scar and had a bruise extending through the peel. This banana when removed from the bunch was yellow in color beneath the decayed area and gradually shaded over to green towards the other end." It was this banana which I referred to as a half-ripe banana in the previous quoted paragraph. It is evident that the Mediterranean fruit-fly was not bred from bananas growing under natural conditions, due to the fact that the fruit was removed from bunches on trees that had been cut down.

Back and Pemberton (1, p. 802) also write, "The fact that Severin reared numerous specimens of the decay flies, *Acrotochæta pulvinata*, *Euxesta annonæ* Fab., and *Notogramma stigma* Fab., besides a number of species of Drosophilidæ, is ample evidence that the trees from which the two fruits were taken had been cut sufficiently long for decay to have started in many fruits, had he not stated that one of the two fruits from which he reared adult flies was in a bruised and decaying condition and that its pulp had already turned yellow beneath the decayed area." In their evidence submitted, however, the authors fail to take into consideration that we (5, p. 448) have published the fact that "the Anthomyid and two species of Ortalids mentioned above were also bred frequently from green Chinese bananas removed from bunches on growing trees in banana plantations. These bananas were decayed around the flower scar. . . ."

Kirk (3, p. 9), of New Zealand, was forced to burn consignments of fruits, including the banana, because they were infested with the maggot of the Mediterranean fruit-fly. Back and Pemberton (1, pp. 801–2) state that "from the arrangement of the text of Kirk's bulletin, the Mediterranean fruit-fly (*Ceratitis capitata*) is definitely listed as a banana pest. The bulletin is, however, a compilation taken for the most part verbatim from various articles on fruit-flies appearing in the Reports of the Agricultural Department of New Zealand, or from circulars issued by the department. A person unfamiliar with the Australian situation is at a loss to know to which of several fruit-fly pests reference is made in the reports of fruits found infested by maggots at the ports of entry. Thus, in the Thirteenth Volume of the Agricultural Reports, 1905, where the list including the banana among those fruits found infested was originally published, no reference is made to either the Queensland or the Mediterranean fruit-fly; it is merely stated that the fruits listed were burned because found infested with the 'dread maggot.' In the report for 1906 it is definitely stated that only the Queensland fruit-fly (*Dacus tryoni*) was reared that year from a list of fruits including the banana. The biologist of Western Australia in his report for the year 1898 stated that the Queensland fruit-fly had been brought to Western Australia in bananas."

In order to convince the most skeptical that the Mediterranean fruit-fly was bred from bananas by Kirk, of New Zealand, I shall publish the following sentences from a letter written March 5, 1913, by Kirk to me on this subject: "The Mediterranean fly which is mentioned in my reports as having been obtained from bananas and pineapples were bred from maggots obtained from imported fruit of those varieties. I cannot now state positively the variety of banana. . . ."

Back and Pemberton (1, p. 802) write, "French, of Victoria, Australia, states that adults of the pest were reared from bananas (*Musa* sp.) exported from Queensland, Australia, and that on many occasions he has proved eggs to have been deposited in green bananas before shipment from Queensland to Melbourne. Both Kirk and French are aware that the Queensland fruit-fly (*Dacus tryoni*) is a pest of bananas grown in Queensland and that confusion between the two fruit-flies might occur if observations were made by untrained inspectors."

The following quotation shows that French (2, p. 4) and his son conducted the breeding experiments of the Mediterranean fruit-fly from bananas on one occasion at least: "The following is an account of some experiments, dealing with the Mediterranean fly, which were carried out by the Assistant Entomologist (Mr. C. French, jun.) and myself during 1906."

"The larvæ of this fly were found in bananas imported from Queensland on the 14th August, and on being placed in the breeding jars pupated on the 20th August; the perfect insects emerged on the 4th October and lived for several weeks, water, with a little sugar added, being the food placed at their disposal."

In the Hawaiian Islands certain varieties of bananas are not immune from the attacks of the Mediterranean fruit-fly under natural conditions. Mr. J. C. Bridwell, formerly in connection with the Hawaiian Board of Agriculture, bred the Mediterranean fruit-fly from ripe bananas of the Popoulu variety and from a green Moa variety. The Moa variety, however, was mature and about to turn yellow and in addition, the peel was so cracked that the pulp was well exposed (1, pp. 795–6).

Bibliography

(1) Back, E. A. and Pemberton, C. E., 1916. Banana as a Host Fruit of the Mediterranean Fruit-fly. Jour. Agr. Research, V, No. 17, pp. 793–804.

(2) French, C., 1907. Fruit-flies. Dept. Agr. Intell. South Australia, Bul. No. 24, pp. 1–14.

(3) Kirk, T. W., 1909. Fruit-flies. New Zealand Dept. Agr. Div. Biol., Bul. 22, pp. 1–18.

(4) Severin, H. H. P., and Hartung, W. J., 1912. Will the Mediterranean Fruit-fly (*Ceratitis capitata* Wied.) Breed in Bananas under Artificial and Field Conditions? Mon. Bul. State Com. Hort. Cal. I, No. 9, pp. 566–9.

(5) SEVERIN, H. H. P. and HARTUNG, W. J., 1912. Will the Mediterranean Fruit-fly (*Ceratitis capitata* Wied.) Breed in Bananas under Artificial and Field Conditions? Jour. Econ. Ent. V, No. 6, pp. 443–451.

(6) SEVERIN, H. H. P., 1913. Precautions Taken and the Danger of Introducing the Mediterranean Fruit-fly (*Ceratitis capitata* Wied.) into the United States. Jour. Econ. Ent. VI, No. 1, pp. 68–73.

CHAIRMAN A. W. MORRILL: As we shall probably have plenty of time we might as well discuss the papers as we go along. Discussions are now in order.

Mr. Dudley Moulton, Prof. R. W. Doane, E. O. Essig and Dr. Severin took part in the discussion which followed.

CHAIRMAN A. W. MORRILL: The next paper will be read by Mr. G. F. Ferris.

METHODS FOR THE STUDY OF MEALY-BUGS

By G. F. FERRIS, *Stanford University, California*

The economic importance, both actual and potential, of certain of the mealy-bugs renders the problem of recognizing the various species one of more than merely academic interest. It is the problem of discriminating between foe and foe or foe and neutral and thus it is of direct interest and of directly perceptible importance to the economic entomologist especially in California where certain species of mealy-bugs are among the worst of pests.

However, it is no exaggeration to say that of the nearly 100 species of mealy-bugs and their allies thus far described from North America, including some 35 from California, not more than three or four are recognizable at all on the basis of the existing literature if taken apart from their typical host and their type locality. Furthermore these three or four are not at all times and under all circumstances recognizable with certainty, even upon the basis of the direct comparison of specimens, by means of the methods and the characters at present in use.

In support of this latter statement I may adduce as evidence the fact that I have at hand at the present time a slide mount of a Pseudococcus determined by one who is perhaps as familiar with the mealy-bugs of this state as anyone and labeled "*Pseudococcus citri.*" The slide contains four specimens and of these three are *Pseudococcus longispinus* and one is *Pseudococcus obscurus*, or as it is better known, *Pseudococcus bakeri*. This is a confusion of three of the most widely spread and most familiar species of the state. Nor is this by any

means an isolated instance of the confusion of these species. To emphasize further the degree of confusion that exists in this group it may be added that the material labeled "type" of one species described from this state contains specimens of three species belonging to as many different genera. Another species is based upon the male of a Ceroputo and the female of a Pseudococcus and there are at least two others which appear to be based upon two different species.

The existence of the present unsatisfactory conditions affords grounds for a justly severe criticism of the methods of systematic entomology as they have been applied in this particular group. However, this is a question which it would be out of place to pursue further. The present paper is concerned only with a consideration of the means by which the existing conditions may perhaps be changed for the better.

The present confusion may be ascribed to two factors, operating both separately and together.

Of these factors one is to be found in the continued use by coccidologists, as specific criteria, of the relative lengths of the segments of the antennæ, expressed in the so-called antennal formulæ. The weakness of these antennal formulæ as diagnostic characters has been implied or even openly admitted even by those who have most consistently clung to them and has been most conclusively demonstrated by Smith[1] who found that the formulæ of ten antennæ of each of five species of Pseudococcus "varied as much as the specifically diagnostic formulæ published for all the species of Pseudococcus." Yet it is upon such characters as these that most authors have based their new species and their discussions in regard to specific relationships. Other characters usually given as supplementary to the antennal formulæ are equally non-significant, as was also pointed out by Smith in the paper already referred to.

Attempts have been made to refine the usual method of presenting these antennal formulæ by embodying them in graphs, but the result is hardly satisfying for no clue is afforded by these graphs to the specific identity of the individuals upon which the graph is based. Inasmuch as two or even more species may occur together upon the same host this objection is serious. Furthermore, the construction of such graphs requires several individuals and does not aid in the identification of isolated specimens.

The effect of the use of these formulæ has been not only to render useless practically all the published descriptions but also, because of the painfully evident variability of the antennæ, to induce the belief that the mealy-bugs are inherently variable in all their structures,

[1] Smith, P. E. Specific Characters Used in the Genus Pseudococcus. Annals Entomological Society of America, vol. 4, pp. 309-327. (1911.)

and present no stable characters upon which determinations may be based. As a matter of fact such a conclusion is very far indeed from the actual facts.

The second factor, and that with which this paper is really concerned, lies in the lack of a satisfactory technique for the preparations of specimens for study. The usual method has been to clear the specimens in caustic potash and then to mount in balsam or to mount in balsam without clearing, the results in either case not being especially fortunate. In some cases the specimens become so clear that it is even difficult to find them on the slide and in no case can anything more than the antennæ and legs be seen without an inordinate amount of eyestraining. In nearly all cases the characters that are actually of the greatest value can not be seen at all. Because of all this, determinations made by the comparison of specimens with types are frequently no more to be relied upon than those made upon the basis of the literature.

The solution of the difficulty lies in the utilization of a means of staining the specimens in order to accentuate the characters that are of especial importance. This is a method that has not usually been popular, probably in part because the methods usually recommended are more or less time consuming and in part because it has not really been shown that these methods produce results of any especial value.

For the staining of coccid preparations in general and for the particular method here advocated the author claims no originality whatsoever. It is believed, however, that it has not before been asserted that for the satisfactory study of mealy-bugs and their allies the use of properly stained preparations is not only desirable but is in fact necessary. It is the non-use of such methods that has previously prevented at least one author from producing results that would have rendered the present paper entirely unnecessary.

The method used has been essentially that recommended by Stafford[1] for use with Diaspine scales, but with modifications chiefly directed toward a general reduction in the amount of time consumed. It is applicable to other insects than coccids for it has proven eminently satisfactory for use with certain aphids, particularly Chermes and Phylloxera, and with the larvæ of Cecidomyidæ. The stain used is Magenta Red and may be purchased in liquid form. It should be diluted to one-half or one-fourth its original strength with water when used.

In its essentials the method is extremely simple. The specimens to be prepared are boiled in caustic potash in the usual manner and then

[1] Stafford, E. W. Studies in Diaspinine Pygidia. Annals Entomological Society of America, vol. 8, pp. 67–73. (1915.)

removed to clean water in which the body contents are washed out with more than usual care. They may then be transferred directly to the stain, which for this purpose is most conveniently contained in deep-hollow slides having a ground glass surface upon which data may be written, covered with a cover glass and set away. Six hours in the stain is sufficient, this being in strong contrast to the 100 hours recommended by Stafford. The specimens are removed from the stain into 95 per cent alcohol in which the excess stain is washed out, are then placed for an instant in carbol-xylene and mounted in balsam.

The result is a preparation in which all chitinized portions, the antennæ, legs, setæ and chitinized areas, are stained a more or less deep red while the remainder of the derm is left practically unstained. It not only becomes easier to study the characters that can be seen in the usual mounts but other characters are brought out that are not ordinarily to be seen and that have not, as far as I am aware, previously been noted by any one.

Smith[1] has pointed out the possible value as specific criteria of the "cerrari" or groups of pores and differentiated spines that occur on the margin of the body and these structures are indeed of much importance. In fact it is probable that a much more satisfactory basis for generic groupings can be found in the number of pairs of these cerrari than in the characters at present used and they are also of value for the recognition of species.

In addition to these cerrari, however, there occur in some species, certain chitinized and deeply staining areas associated especially with the cerrari of the anal lobes and on the ventral side of these lobes. It is these areas of which I have previously spoken as characters not previously noted. They are remarkably constant in shape and extent and permit the instant and certain recognition of some species. In other species they are not present, in which case the cerrari alone must be relied upon. With the use of all these characters, the cerrari, the dorsal and ventral body setæ and the chitinized areas, the distinguishing of the various species of mealy-bugs becomes in general practically no more difficult than the distinguishing of the various species of diaspine scales. The differences are readily appreciable and are no more variable than those which must be used in almost any group. Given proper study upon the basis of adequate material and with the aid of the methods here advocated, or of equivalent methods, the present confusion in the "soft scales" should rapidly disappear.

[1] Smith, P. E. A Study of Some Specific Characters of the Genus Pseudococcus. Journal of Entomology and Zoölogy, vol. 5, pp. 69, 81, figs. (1913.)

The paper was followed by a discussion by several members as to more detail in the methods used.

CHAIRMAN A. W. MORRILL: The next paper will be presented by H. E. Burke.

NOTES ON SOME WESTERN BUPRESTIDÆ[1]

By H. E. BURKE,

Specialist in Forest Entomology, Bureau of Entomology, U. S. Department of Agriculture

During the past fifteen years various members of the Branch of Forest Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture, have made a number of observations on the life-histories and food plants of numerous species of western flathead borers or Buprestidæ. Some of these species are injurious to native and introduced fruit and shade trees and some other species may soon become so. One wood-infesting species has become a household pest and is doing some damage to interior wood work in the mountain towns.

Most of the species discussed inhabit deciduous trees but a few that may become pests of coniferous shade trees are included. In all cases the host plants listed are those from which the larva or adult has been taken from the wood or bark and not just resting on the foliage or bark. The fact that adults are found on the foliage or bark of a plant time after time is a good observation and worthy of record. It is also a good indication that the borer lives in the plant. There are cases, however, where it is not true and, in the writer's opinion, no plant should be listed as a host plant of a boring insect unless the insect is found living in the plant.

Some of the observations made on the feeding and egg-laying habits of the adults have suggested new methods of control and also, when considered with the life-history studies, new taxonomic relations.

In all, forty-four species are listed. Forty-three of these are western and from the following states: South Dakota, Montana, Colorado, New Mexico, Idaho, Utah, Arizona, Washington, Oregon and California. One southern species is included to complete the host plants of the genus Trachykele. There are no records from Wyoming and Nevada but many of the species listed undoubtedly occur in those states.

The names as given follow Henshaw's "List of the Coleoptera of America, North of Mexcio." Many of the genera are in a deplorable state but the names given are those commonly used. The doubtful species have been verified by Mr. W. S. Fisher of the Branch of Forest

[1] Published by permission of the Secretary of Agriculture.

Insect Investigations, Prof. E. C. Van Dyke of the University of California and Prof. H. C. Fall of Pasadena, California.

Dicerca prolongata Lec.—Specimens from South Dakota, Colorado, Montana, Utah, Oregon and California; mines wood of injured, dying and dead trees; willow (*Salix* sp.), aspen (*Populus tremuloides*) and black cottonwood (*P. trichocarpa*); flies from July to September; feeds on bark of host plant; may attack planted poplars.

Dicerca obscura Fab.—What appears to be this common eastern species has been taken at Chico, California, in the wood of the Oregon ash (*Fraxinus oregona*); mines wood of injured, dying and dead trees; the eastern host plants are white oak (*Quercus alba* Linn.) and persimmon (*Diospyros virginiana*); flies from April to September. May become injurious to planted oak, ash and persimmon.

Dicerca hornii Cr.—Montana, Idaho, Washington, Oregon and California; mines wood of injured, dying and dead trees and shrubs; white alder (*Alnus rhombifolia*), mountain alder (*A. tenuifolia*), mountain mahogany (*Cercocarpus parvifolius*), plum (*Prunus domestica*), sweet cherry (*P. avium*), sumach (*Rhus glabra occidentalis*), poison oak (*Toxicodendron diversiloba*), California buckeye (*Æsculus californica*), coffee berry (*Rhamnus californica*), deer brush (*Ceanothus integerrimus*), blue brush (*C. thyrsiflorus*), buck brush (*C. cuneatus*) and snow berry (*Symphoricarpos racemosus*); flies from March to August; attacks domestic plum and cherry and probably other fruit trees; causes severe injury to the alder.

Dicerca sp. close to divaricata Say—Montana and Colorado; mines wood of dying and dead trees; mountain birch (*Betula fontinalis*), mountain alder (*Alnus tenuifolia*), bitter cherry (*Prunus emarginata*) and choke cherry (*P. demissa*); flies from July to September; may attack planted birches and rosaceous fruit trees.

Trachykele blondeli Mars.—Washington, Oregon and California; mines wood of normal, injured, dying and dead trees; giant arborvitæ (*Thuja plicata*), monterey cypress (*Cupressus macrocarpa*), McNab cypress (*C. macnabiana*) and western juniper (*Juniperus occidentalis*); flies from April to August; attacks planted cypress and probably other planted cedarlike trees.

Trachykele opulenta Fall—California; mines wood of normal, injured, dying and dead trees; California bigtree (*Sequoia washingtoniana*) and incense cedar (*Libocedrus decurrens*); flies April to June; attacks planted incense cedar and probably bigtree and redwood.

Trachykele nimbosa Fall—Oregon and California; mines wood of normal, injured, dying and dead trees; alpine hemlock (*Tsuga mertensiana*), white fir (*Abies concolor*) and red fir (*A. magnifica*); flies during June and July; may attack planted fir.

Trachykele lecontei Gory—Virginia, North Carolina, South Carolina and Louisana; mines wood of injured, dying and dead trees; bald cypress (*Taxodium distichum*); flies from March to July; may attack planted bald cypress.

Pœcilonota cyanipes Say (?)—Colorado, New Mexico and Utah; mines wood of injured trees; aspen (*Populus tremuloides*) and common cottonwood (*P. deltoides*); flies from August to September; may attack planted poplars.

Pœcilonota ferrea Melsh. (?)—California; mines bark and wood of injured trees; aspen (*Populus tremuloides*) and nuttall willow (*Salix nuttallii*); flies from July to September; may attack planted willows and poplars.

Pœcilonota thureura Say (?)—Montana and Oregon; mines bark of normal trees; black cottonwood (*Populus trichocarpa*); flies in July and August; lays its eggs in crevices in the bark; may attack planted cottonwoods but according to Mr. Josef Brunner prefers the older thick-barked trees.

The classification of this genus is in a deplorable state and all of these species may be wrongly identified.

Buprestis confluens Say—Colorado, Utah and California; mines wood of injured, dying and dead trees; aspen (*Populus tremuloides*) and common cottonwood (*P. deltoides*); flies from July to September; attacks planted cottonwood.

Melanophila drummondi Kirby—Practically all of the Rocky Mountain and Pacific states; mines inner bark and outer wood of normal, injured, dying and dead trees; western larch (*Larix occidentalis*), Engelmann spruce (*Picea engelmanni*), sitka spruce (*P. sitchensis*), western hemlock (*Tsuga heterophylla*), alpine hemlock (*T. mortensiana*), douglas spruce (*Pseudotsuga taxifolia*), alpine fir (*Abies lasiocarpa*), lowland fir (*A. grandis*), white fir (*A. concolor*), lovely fir (*A. amabilis*), noble fir (*A. nobilis*) and red fir (*A. magnifica*); flies from May to September; attacks and kills many trees, also causes defects to form in the wood of others; may attack coniferous shade trees.

Heretofore, has been mixed with the following species. *Melanophila sp.*—California; mines inner bark and wood of normal, injured, dying and dead trees; yellow pine (*Pinus ponderosa*), jeffrey pine (*P. jeffreyi*) and digger pine (*P. sabiniana*); flies from June to August; kills many second growth trees and assists Dendroctonus species to kill others.

Melanophila gentilis Lec.—Practically all of the Rocky Mountain and Pacific states; mines inner bark and wood of normal, injured, dying and dead trees; sugar pine (*Pinus lambertiana*), yellow pine (*P. ponderosa*), rock pine (*P. scopulorum*) and jeffrey pine (*P. jeffreyi*);

flies from March to August: attacks and kills small and large trees; very injurious to second growth in some localities; is the principal enemy of the sugar pine outside of *Dendroctonus monticolæ* Hopk.

Melanophila intrusa Horn—Colorado and California; mines inner bark of injured, dying and dead trees; sugar pine (*Pinus lambertiana*), yellow pine (*P. ponderosa*) and rock pine (*P. scopulorum*); flies in June and July; usually lives in the suppressed limbs and tops but sometimes infests saplings; the larva indicates that it is quite different from the other Melanophila.

Anthaxia ænogaster Lap.—Practically all of the Rocky Mountain and Pacific states; mines bark and outer wood of normal, injured, dying and dead trees and shrubs; sugar pine (*Pinus lambertiana*), pinon pine (*P. edulis*), yellow pine (*P. ponderosa*), jeffrey pine (*P. jeffreyi*), digger pine (*P. sabiana*), knobcone pine (*P. attenuata*), Monterey pine (*P. radiata*), douglas spruce (*Pseudotsuga taxifolia*), weeping willow (*Salix babylonica*), garry oak (*Quercus garryana*), mountain mahogany (*Cercocarpus parvifolius*), service berry (*Amelanchier alnifolia*) and redbud (*Cercis occidentalis*); flies from March to September; commonly lives in the branches but often attacks and kills saplings and shrubs; very injurious to the redbud in some localities. It appears to the writer that there must be several species mixed.

Chrysobothris femorata Fab.—Montana, Colorado, Idaho, Arizona, and California; mines inner bark and wood of normal, injured, dying and dead trees; willow (*Salix* sp.), aspen (*Populus tremuloides*), black cottonwood (*P. trichocarpa*), lombardy poplar (*P. nigra italica*), gambel oak (*Quercus gambeli*), live oak (*Q. chrysolepis*), black oak (*Q. californica*), wild plum (*Prunus americana*), prune (*P. domestica*) and imported maple (*Acer dasycarpum*); flies from March to September; sometimes causes severe injury to poplar and maple shade trees as well as fruit trees. Many of the published records of this species in the west refer to *Chrysobothris mali*.

Chrysobothris mali Horn—Oregon and California; mines inner bark and wood of normal, injured and dying trees and shrubs; arroyo willow (*Salix lasiolepis*), mountain mahogany (*Cercocarpus parvifolius*), apple (*Pyrus malus*), christmas berry (*Heteromeles arbutifolia*), plum (*Prunus domestica*), wild plum (*P. subcordata*), peach (*P. persica*), Oregon maple (*Acer macrophyllum*) and box elder (*A. negundo*); flies from May to August; lays its eggs singly in crevices in the bark; causes severe injury to shade and fruit trees; all of the Chrysobothris reared from the apple in California by the writer are of this species. These rearings were from Siskiyou, El Dorado and Los Angeles counties.

Chrysobothris nixa Horn—California; mines inner bark and wood of normal, injured, dying and dead trees; incense cedar (*Libocedrus decur-*

rens) and monterey cypress (*Cupressus macrocarpa*); flies from March to August; kills saplings and small trees. Very common in felled incense cedar. Reared once from the monterey cypress by Mr. F. B. Herbert.

Thrincopyge ambiens Lec.—Arizona; mines flower stems of the sotol (*Dasylirion wheeleri*); flies July and August; may infest yuccas and closely related plants.

Polycesta californica Lec.—Oregon and California; mines wood of injured, dying and dead trees and shrubs; cottonwood (*Populus fremonti*), white alder (*Alnus rhombifolia*), garry oak (*Quercus garryana*), douglas oak (*Q. douglasii*), interior live oak (*Q. wislizeni*), black oak (*Q. californica*), mountain mahogany (*Cercocarpus parvifolius*), apple (*Pyrus malus*), pear (*P. communis*); christmas berry (*Heteromeles arbutifolia*), almond (*Prunus amygdalus*), redbud (*Cercis occidentalis*), Oregon maple (*Acer macrophyllum*) and manzanita (*Arctostaphylos viscida*); no specimens collected flying; emerges from host plant early in summer; causes some injury to fruit and shade trees.

Polycesta elata Lec.—Arizona; mines wood of injured, dying and dead trees; Arizona white oak (*Quercus arizonica*), emory oak (*Q. emoryi*), white leaf oak (*Q. hypoleuca*), hackberry (*Celtis reticulata*) and Arizona sycamore (*Plantanus wrightii*); no specimens collected flying; causes some injury to shade trees.

Polycesta velasco L. & G.—Arizona; mines wood of injured, dying and dead trees; catsclaw (*Acacia greggii*), mosquite (*Prosopis juliflora*) and palo verde (*Cercidium torreyanum*); no specimens collected flying; causes some injury to shade trees; may attack introduced acacias.

Acmœodera amabilis Horn—Arizona; mines wood of dead trees; alder (*Alnus tenuifolia*); may attack shade trees.

Acmœodera plagiaticauda Horn—California; mines wood of injured shrubs; manzanita (*Arctostaphylos viscida*); may injure planted shrubs.

Acmœodera angelica Fall—California; mines wood of injured and dying trees and shrubs; douglas oak (*Quercus douglasii*), poison oak (*Toxicodendron diversiloba*), deer brush (*Ceanothus integerrimus*) and buck brush (*C. cuneatus*); may injure planted oaks and shrubs.

Acmœodera hepburnii Lec.—California; mines wood of injured and dying trees; garry oak (*Quercus garryana*), douglas oak (*Q. douglasii*), interior live oak (*Q. wislizeni*) and pear (*Pyrus communis*); flies in May and June; injures fruit and shade trees by mining the wood and weakening the trunk.

Acmœodera acuta Lec.—California; mines wood of injured and dying trees; douglas oak (*Quercus douglasii*); may injure planted trees.

Acmœodera connexa Lec.—California; mines wood of injured trees; interior live oak (*Quercus wislizeni*); flies from May to July; injures shade trees.

Acmæodera van dykei Fall—California; mines wood of injured roots; interior live oak (*Quercus wislizeni*); flies from May to July; may attack shade trees.

Acmæodera cuneata Fall—Arizona; mines wood of injured and dying trees; alder (*Alnus tenuifolia*); may attack shade trees.

Acmæodera sp. near prorsa Fall.—California; mines wood of scars on living trees; interior live oak (*Quercus wislizeni*) and black oak (*Q. californica*); may injure shade trees.

Acmæodera mariposa Horn—Oregon and California; mines wood of injured and dying shrubs; mountain mahogany (*Cercocarpus parvifolius*), christmas berry (*Heteromeles arbutifolia*), poison oak (*Toxicodendron diversiloba*), coffee berry (*Rhamnus californica*), deer brush (*Ceanothus integerrimus*), blue brush (*C. thyrsiflorus*) and redbud (*Cercis occidentalis*); flies from April to June; feeds on the foliage of the hostplant; may attack planted shrubs.

Acmæodera sp. near pulchella Herbst.—Colorado and Utah; mines wood of injured and dying trees; gambel oak (*Quercus gambelii*); flies in July; may attack shade trees.

Chrysophana placida Lec.—Colorado, Utah, Washington, Oregon and California; mines cones and wood of normal, injured, dying and dead trees; mountain white pine (*Pinus monticola*), sugar pine (*P. lambertiana*), single leaf pinon (*P. monophylla*), yellow pine (*P. ponderosa*), rock pine (*P. scopulorum*), jeffrey pine (*P. jeffreyi*), lodgepole pine (*P. murrayana*), digger pine (*P. sabiniana*), knobcone pine (*P. attenuata*), alpine hemlock (*Tsuga mertensiana*), douglas spruce (*Pesudotsuga taxifolia*), alpine fir (*Abies lasiocarpa*), white fir (*A. concolor*), red fir (*A. magnifica*) and giant arborvitæ (*Thuja plicata*); flies from March to September; is destructive to seed crop of knobcone pine; damages pine window and door casings in buildings and may attack wood of planted coniferous trees.

Agrilus angelicus Horn—California; mines twigs and small branches of normal trees; live oak (*Quercus agrifolia*); flies from May to July; feeds on the foliage of the host plant; lays its eggs singly on the outer bark of the twigs; girdles and kills twigs and small branches; damages shade trees by causing a ragged or scraggy appearance; takes two years for the life cycle. The published records on this distinct species are under *Agrilus politus* Say.

Agrilus sp.—California; mines bark and wood of branches and main trunks of normal shrubs and trees; madrone (*Arbutus menziesii*) and manzanita (*Arctostaphylos manzanita* and *A. viscida*); flies from May to August; feeds on the foliage of the host plant; lays its eggs singly on the smooth bark of the branches and trunk; girdles and kills branches and causes the formation of enlarged galls; takes two years for the life

cycle; may damage ornamental shrubs and shade trees. Some taxonomists consider this the same as the preceding species but the life-history and habits indicates that it is distinct.

Agrilus niveiventris Horn—California; mines inner bark and wood of normal and dying trees; lombardy poplar (*Populus nigra italica*); flies from May to August; feeds on the foliage of the willow (*Salix lasiandra* and *S. lasiolepis*) and the host plant; lays its eggs singly in crevices in the bark; girdles and kills shade trees, sometimes causing severe damage.

Agrilus granulatus Say—Colorado and Montana; mines inner bark and wood of normal, dying and dead trees; willow (*Salix* sp.), black cottonwood (*Populus trichocarpa*) and common cottonwood (*P. deltoides*); girdles and kills limbs and trunk. Injurious to shade trees in Colorado.

Agrilus anxius Gory—South Dakota, Montana, Colorado, Idaho and Utah; mines inner bark and wood of normal, dying and dead trees; aspen (*Populus tremuloides*), common cottonwood (*P. deltoides*) and mountain birch (*Betula fontinalis*); flies from May to August; girdles and kills branches and trunk; causes severe damage to shade trees.

Agrilus acutipennis Mann.—Colorado; mines inner bark and wood of normal, injured and dying trees; gambel oak (*Quercus gambelii*); flies from June to August; feeds on the foliage of the host plant; lays its eggs in the crevices of the bark; girdles and kills branches and trunk; very destructive to native groves of oak in Colorado according to Mr. George Hofer.

Agrilus politus Say—Montana, Colorado, Oregon and California; mines inner bark and wood of normal, injured and dying trees and shrubs; mountain willow (*Salix monticola*), nuttall willow (*S. nuttallii*), arroyo willow (*S. lasiolepis*), weeping willow (*S. babylonica*), mountain alder (*Alnus tenuifolia*) and dwarf maple (*Acer glabrum*); flies from May to August; feeds on foliage of host plant; lays its eggs in masses of from one to twelve on the smooth bark of branches and trunk; girdles and kills branches and main trunk; life cycle appears to vary; Mr. Josef Brunner considers it to be two years in Montana but it seems to be only one in some parts of California; very destructive to alder in some parts of Montana and to willow in California; attacks weeping willow shade trees. There may be several species still mixed under this name. In practically all of our rearings greenish specimens occasionally appear. These have been identified by Mr. W. S. Fisher as *Agrilus solitarius* G. & H. The next species which is dark blue has also been considered a variety of politus but the life history and habits indicate that it is distinct.

Agrilus sp.—Oregon and California; mines inner bark and wood of

normal, injured and dying trees; white alder (*Alnus rhombifolia*) and mountain alder (*A. tenuifolia*); flies from April to July; feeds on foliage of host plant; lays its eggs in masses of from one to twelve on the smooth bark of branches and trunk; girdles and kills branches and trunk; life cycle seems to be one year; very destructive to the white alder in some parts of California; when an attack does not kill the tree it causes rough scars on the trunk and swollen galls on the branches; appears to be the only species that attacks the alder in California.

From an economic standpoint the two main points brought out by the preceding observations are: first, that the adults of some of the most injurious species feed on the foliage of the host plant where they may be fought with poison sprays; second, that they lay their eggs upon the bark where they may be reached by contact sprays.

Up to the present time the general methods of control recommended for flathead borers have been the cutting out and burning of the infested parts or the protection of the plant by repellent washes or protective coverings. These methods when carefully applied are very effective and will continue to be important but along with them the measures suggested in the preceding paragraph have their place and in many cases their prompt use ought to make the severer measures unnecessary.

Take, for instance, *Agrilus politus* which causes severe damage to the alder and willow often killing many trees in a group. The adults feed on the leaves and then lay their eggs on the smooth bark of the limbs and main trunk. An arsenic spray on the foliage should kill the adults and any of the oil or sulphur sprays should destroy the eggs on the bark. And the result should be the same in the case of *Chrysobothris mali* which is a destructive enemy of shade and fruit trees.

The main point in the use of any of these measures is careful observation to determine the amount of damage the insect is doing, the exact time when the control work should be done, that the proper method is selected to suit the particular conditions found and that the method used is properly applied. The most perfect remedy will not bring the best results unless it is used in the right place at the right time.

CHAIRMAN A. W. MORRILL: As it is now lunch time we had better adjourn until 2 p. m. as announced on the program.

Adjourned

After a very fine luncheon provided by the members of Stanford University for all members of visiting societies the meeting was called to order at 2 p. m. by Chairman A. W. Morrill.

CHAIRMAN A. W. MORRILL: The first paper for this afternoon will be read by Dr. H. H. P. Severin.

FRUIT-FLIES OF ECONOMIC IMPORTANCE IN CALIFORNIA

By HENRY H. P. SEVERIN, *Berkeley, Cal.*

(Withdrawn for publication elsewhere)

The paper was discussed by H. E. Burke, A. W. Morrill, R. W. Doane and others.

CHAIRMAN A. W. MORRILL: The next paper, by Prof. A. L. Lovett, will be read by the secretary.

NICOTINE SULPHATE AS A POISON FOR INSECTS

A. L. LOVETT, *Entomologist, Oregon Agricultural Experiment Station*

A suggestion of nicotine sulphate as a stomach poison for insects was first brought to the writer's attention after reading the report of Mr. F. E. DeSellem, inspector at large, of North Yakima, Washington, on Black Leaf 40 as a spray for the codling moth.

Since the completion of the work included in this paper, has appeared the excellent article on "Nicotine as an Insecticide" by Mr. McIndoo, in the *Journal of Agricultural Research*, and still more recently the 1916 Horticultural Report of Yakima County, Washington, with the two seasons' rather startling results of Mr. DeSellem on the control of the codling moth. The results included in this paper supplement both in a measure and are offered as additional data on a very interesting topic. Nicotine sulphate as a contact insecticide is considered a very efficient, but expensive spray. The possibility of its broader insecticidal properties in commercial spraying as indicated in these papers may alter our present conception as to value versus service.

SERIES 1. FOR FOLIAGE EATING CATERPILLARS

The caterpillars used in the tests were our common tent caterpillars (*Malacosoma pluvialis* Stretch). They were collected, tent and all, in the field feeding on the foliage of the wild rose. With the exception of Experiment A the foliage was allowed to dry for hours after applying the spray before introducing the caterpillars.

EXPERIMENT A.

April 9, 1916. 9.00 a. m.

Sprayed foliage of wild rose with "Pratt's Nicotine 40" 1–400, thoroughly saturating the foliage with a fine misty spray. Placed approximately 600 newly hatched larvæ of the tent caterpillar (*M.*

pluvialis) on the wet foliage. The caterpillars exhibited a most decided aversion to the sprayed foliage, crawling about, collecting in masses and suspending themselves on elongated web ropes and dropping off. By noon, fully 60 per cent were apparently dead, though none had fed. These died in a balled up heap in the center of the mass of foliage. The few remaining caterpillars were restless, sick and writhing about. Observations at 5.00 p. m. showed about all dead; some which had dropped apparently dead, showed signs of life, but were very sick. The next morning, April 10, all were dead or had left. A fair per cent of those which dropped had recovered and crawled away. One small incision in the margin of a leaf was observed, but there were no other apparent signs of feeding.

EXPERIMENT B.

April 13, 1916. 8.45 p. m.

Sprayed foliage of apple as follows:

No. 1, Pratt's Nicotine 40 1–800

No. 2, Black Leaf 40 1–1200

Applied as fine misty spray thoroughly saturating foliage. Placed on table to dry. April 14, 9.00 a. m., placed approximately 300 small caterpillars on each No. 1 and No. 2. Foliage perfectly dry.

The caterpillars showed a decided aversion, were restless, crawled about, formed long web ropes and dropped off. Often one would be observed to rear the head and half of the body from the foliage, writhe about and spew up drops of dark liquid as grasshoppers do, apparently very sick. At 3.00 p. m., 50 per cent were apparently dead, the others very sick. Many which had dropped and lay curled in grotesque positions as though having died in great pain, eventually recovered (after 3 hours or more) and crawled away. The following day, April 15, a few were observed to have fed on both Nos. 1 and 2. Where they had fed, they were apparently in all cases really dead. One fact stood out particularly, of the many which had dropped, apparently dead, without having fed, they had almost without exception, recovered and crawled away. The drop on No. 2 was a little heavier than on No. 1, with a little more feeding indicated on No. 1. The caterpillars were about all dead or had crawled away the next day, April 16, from both Nos. 1 and 2. To see if the action of the material was still effective, 75 fresh caterpillars were placed on No. 2. The action of the caterpillars was the same as that of earlier forms, restless, sick and dropping off. This would indicate that the action, whatever it is, extends over a period of three days at least.

EXPERIMENT C.

May 5, 1916.

Sprayed apple foliage with following:

No. 3, Black Leaf 40, 1–800

No. 4, Black Leaf 40, 1–1200

Thoroughly covered foliage with fine misty spray and allowed to dry for six hours. Placed approximately 1,000 half-mature tent caterpillars on each.

The results were practically identical with those of Experiments A and B with the immature forms. The material was apparently very repulsive, though no odor of nicotine could be detected. The foliage was placed where a breeze could blow across it. The caterpillars continued to act restless, dropped, writhed and spewed. The effect of the spray on these larger forms was slower. Also, more caterpillars were used in the tests. Daily observations were made up until May 19, a total of 14 days, when approximately all had left the sprayed foliage. Each day a number would drop, lie for approximately three hours as though dead, then recover and crawl away. Those which crawled away collected in a mass on the sill of the window. On May 10 and 11 these forms were collected and placed on fresh unsprayed foliage. Here they fed with great gusto and apparently showed no ill effects of the recent illness. On May 11, two caterpillars were found dead on No. 3; the foliage showed small feeding punctures. There were three dead on No. 4, which also showed slight evidence of feeding. The foliage was changed on May 12, first allowing it to dry thoroughly after applying the spray. On May 19, seven caterpillars were dead under No. 3 and 12 under No. 4. Feeding for the entire period amounted to a total of about two fair-sized leaves.

EXPERIMENT D.

May 19.

Dipped camel's hair brushes in Nicotine Sulphate 40 per cent and treated nearly mature caterpillars as follows:

No. 1. Black Leaf 40, 1–800, painted ventral surfaces of 10 caterpillars with moist brush and then placed caterpillars on fresh unsprayed apple foliage.

No. 2. Pratt's Nicotine 40, 1–800, allowed brush to dry for 24 hours, painted ventral surface of 10 caterpillars and placed on fresh unsprayed apple foliage.

No. 3. Black Leaf 40, 1–1200, allowed to dry 24 hours and treated as above.

No. 4. Pratt's Nicotine 40, 1–1200 treated as No. 1.

No. 1 and No. 4 nauseated, spewed up and dropped off; eventually recovered.

No. 2 and No. 3 restless for a time but eventually commenced feeding and were apparently normal. Not sick.

Conclusions

Nicotine sulphate is a very powerful repellent for caterpillars. They will not ordinarily feed from choice on foliage sprayed with it. Where feeding does take place, the action of the nicotine is apparently rapid and sure, even small bits of foliage sprayed with comparatively weak solutions, where devoured, killing after a short time. To what property of the spray one may attribute the general sick condition of the caterpillars is discussed in Mr. McIndoo's paper, page 98. Paralysis of the nerves by the volatile nicotine passing in through the tracheæ as he suggests is the most feasible explanation. The volatilization of nicotine sulphate must be very slow as this material is, theoretically, non-volatile. The possibility of the active agent being absorbed by the feet or through the skin and thus carried to the nerve centers is also suggested.

Series B, For Codling Moth

The tests of nicotine sulphate for the control of the codling moth were very unsatisfactsry and can hardly be considered good experimental data. The immediate cause for failure was an unavoidable late change in plans. The factors which make the test of little value are as follows: The orchard tract available for the test consisted of a run-down orchard of mixed varieties with their necessary individual variations. No comparison was made against the standard lead arsenate application. The nicotine sulphate was used in combination with lime-sulphur instead of soap. The season was a very backward one and the generations of the codling moth were very much delayed. A summary of the test is included in this paper that one may judge the results for whatever value they may have.

Four applications were made: 1, The calyx spray, May 10; 2, When eggs of first generation were deposited, June 16; 3, When first adults of second generation appeared, August 2; and 4, When majority of second generation moths were depositing eggs, September 8.

The following materials were used at each application:

1. Niagara dust sulphur 85 per cent plus Corona lead arsenate 15 per cent, as a dust.
2. Black Leaf 40, 1–400 plus lime sulphur 32° B., 1–35.
3. Pratt's Nicotine 40, 1-800 plus lime sulphur 32°, 1–35.
4. Black Leaf 40, 1–1200 plus lime sulphur 32°, 1–35.

While none of the materials gave satisfactory control, the comparative results are interesting. In the check, there were 29.65 per cent of wormy apples. Nicotine sulphate 1–1200 and 1–800 show but slight control, having respectively 26.8 and 26 per cent of wormy apples.

CODLING MOTH EXPERIMENT WITH NICOTINE SULPHATE

(*Cydia pomonella*)

(Total count 20,296 apples)

Treatment	Total Number of Apples	Sound		Unsound	
		Number	Percentage	Number	Percentage
Untreated Plat I, Baldwins	2,705	2,090	77.26	615	22.74
Untreated Plat II, Yellow Newtons	1,417	899	63.44	518	36.56
Mean			70.35		29.65
Dust (85 per cent sulphur)	513	451		62	
and 15 per cent arsenate	3,156	2,919		237	
Yellow Newtons	3,482	3,166		316	
Mean			91.39		8.61
Black leaf (1–1200), Plat No. II, Northern Spies	725 951	545 763	78.04	180 188	21.95
Black leaf (1–1200), Plat No. II, Yellow Newtons	509	348	68.36	161	31.64
Mean			73.20		26.80
Black leaf (1–400), Plat No. III, Baldwin	4,729	4,005	84.69	724	
Mean					15.31
Pratt's Nicotine 40 (1–800), Plat No. I, Yellow Newtons	711	466	65.54	245	34.45
Pratt's Nicotine 40 (1–800), Plat No. II, Baldwins	1,498	1,235	82.44	263	17.56
Mean			74.00		26.00

Nicotine sulphate 1–400 gave approximately one-half control or 15.31 per cent worms. The dust application gave by far the best control, showing only 8.6 per cent worms. The foliage of the dusted trees showed to an advantage. This material also checked the scab to a very fair degree, though the work was started too late to afford satisfactory control here.

1916. McINDOO, N. E. Effects of Nicotine as an Insecticide. Jour. Agri. Research, VII, pp. 89–121. 1916.

1916. DESELLEM, F. E. Nicotine Sulphate for the Control of the Codling Moth. Yakima County Hort. Rept. 1916, pp. 62–72.

CHAIRMAN A. W. MORRILL: The next paper by Prof. C. P. Gillette and L. C. Bragg will be read by the secretary.

THE MIGRATORY HABITS OF MYZUS RIBIS (LINN.)

By C. P. Gillette and L. C. Bragg

This is one of the best known aphides in both Europe and the United States, occurring upon the leaves of the various species of *Ribes*, especially the common red currant, but also known to attack the leaves of the European black currant, the Rocky Mountain wild currant, *R. aureum*, and occasionally the gooseberry.

Linnæus gave a very good description of this louse including the red leaf galls which it produces, so we are reasonably certain of the species he worked with. It has long been known that it leaves the currant bushes during the middle of the summer, but no one has definitely determined the alternate hosts.

Kaltenbach and Koch may have had this species under observation when studying *galeopsidis* on Stachys, which we have demonstrated is a common summer host of this species in Colorado.

Buckton, vol. II, pl. 39, fig. d, has evidently confounded the red leaf galls of this species with the work of *Rhopalosiphum ribis*, a fact referred to by Schouteden in his "Catalog of the Aphididæ of Belgique," p. 236.

Koch put this species in the genus *Rhopalosiphum*, probably because there is a slight enlargement of the cornicles toward the distal ends where the diameter is greatest.

Dobrovliansky, in *Review of Applied Entomology*, 1914, p. 81, is quoted as saying that this aphid is injurious to the black currant, but says nothing of the possibility of its having a different summer host.

Dr. Patch, in Bulletin 225 of the Maine Experiment Station, p. 55, 1914, mentions this as a common louse upon the currant in Maine and considers it a migrating species, but says that the alternate host plant is unknown.

Prof. H. F. Wilson, in his paper, "Biennial Crop Pests and Horticultural Report of the Oregon Agricultural College and Experiment Station," p. 94, 1912, speaks of this as a migrating species and gives a characterization of its different stages, including the egg, upon the currant, but does not suggest the summer hosts. He also mentions the gooseberry as an occasional host plant.

Van der Goot, in his paper on Blattlaus-Arten, Overgedrukt uit het Tigdschrift voor Entomologie, Deel LV, 1912, p. 72, considers *M. ribis* a migrating species and says it is possible that his *M. lamii* might be the migratory form of *ribis*.

Van der Goot, also, in "Beitrage zur Kenntnis des Hollandischen Blattlause," p. 113, 1915, reports the fall migrants of *M. galeopsidis* coming to the currant and the oviparous females laying eggs upon the

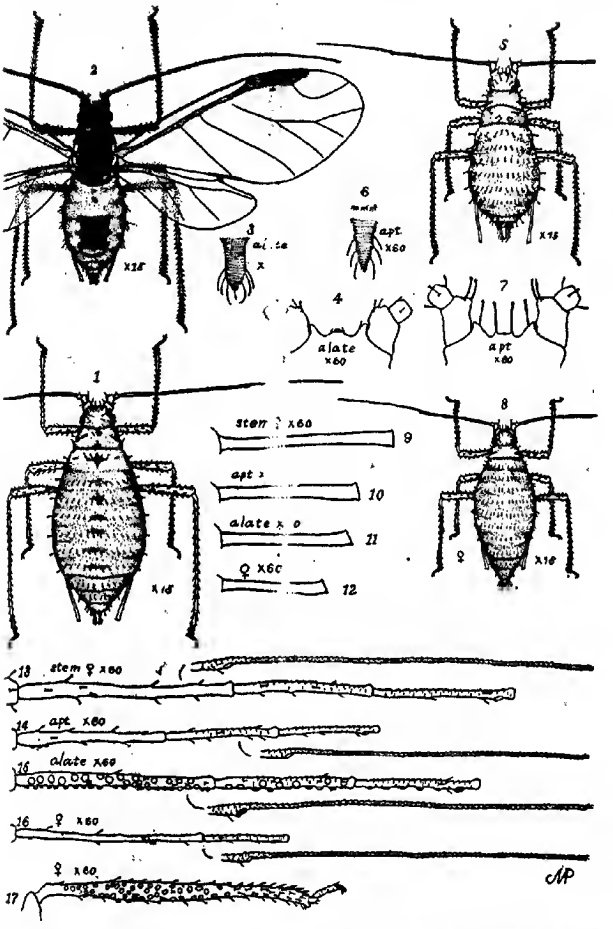

Fig. 17. *Myzus ribis* (Linn.). 1, Stem mother, 9 and 13 the cornicle and antenna of same; 2, alate viviparous female, and 3, 4, 11 and 15, the cauda, vertex, cornicle and antenna of the same; 5, apterous viviparous mother of the males, and 6, 7, 10 and 14, the cauda and gonopophyses, vertex, cornicle and antenna of same; 8, the oviparous female, and 12, 16 and 17 the cornicle, antenna and tibia of same.

Original, Miriam A. Palmer, Illustrator.

The apterous virgogene and the antenna of the alate male differ so little from figures 5 and 15 in the plate, it does not seem necessary to figure them.

twigs. He speaks of taking a similar louse upon *Lamium* and *Stachys* and makes the suggestion that it may be identical with *M. ribis*, but thinks not, as his attempts to transfer early summer—"Vorsommer"—forms to the *Lamium* did not succeed.

We have repeatedly transferred the migrants from the *Ribes* to *Stachys* and *Leonurus* and the fall migrants from these plants to the currant and had them take well, so feel safe in announcing these two genera, at least, as summer hosts of *Myzus ribis* Linn.

For structural details of this species, see Figure 17.

CHAIRMAN A. W. MORRILL: The next paper, by Professor Illingworth, will be read by the secretary.

A TROUBLESOME HOUSEHOLD PEST (ATTAGENUS PLEBIUS SHARP) OF HAWAII

By DR. J. F. ILLINGWORTH, *Professor of Entomology, College of Hawaii, Honolulu*

This insect has habits somewhat closely related to the well-known black carpet beetle (*Attagenus piceus* Ol.) of the United States. My first experience with this pest was upon opening up two trunks, which had been stored for about a year. After arrival in Hawaii we had packed away all of our winter clothing, which was superfluous in a tropical climate, but which we thought might be useful if we ever again visited colder regions. It was certainly a most distressing sight that met our gaze, when the trunks were opened—everything of animal origin was ruined. Our new woolen undersuits were completely riddled; fur, hair and feathers were a mass of fragments; and, worst of all, our heavy, outer clothing was shot full of holes.

I soon discovered that the beetles had not confined their attention to the trunks, for several other objects in the same storeroom were injured. A saddle, padded with sheep-skin, was badly eaten; and even the felt paper, which lined one of my small grips, was almost completely gnawed away. We soon began to find the beetles on the windows in the rest of the house, and occasionally noticed a beginning of their work in the closets. Fortunately, however, they do not give any trouble to clothing or other objects which are used frequently.

During subsequent investigations, I have found that this beetle is often destructive to dried fish in the Honolulu markets, though the principal injury to this product is by the larger dermestid, commonly known in the United States, as the leather beetle (*Dermestes vulpinus* Fab.). Dealers in brushes in Hawaii have also come to know this

pest, for it is frequently closely associated with the buffalo carpet beetle (*Anthrenus scrophulariæ* Linn.) in the destruction of their finest goods. I, also, discovered an interesting relation of these insects to the nesting of the English sparrows. Where these birds are in the habit of nesting on banks or in buildings the beetles are attracted to the masses of feathers and other animal matter used in the nest construction.

Distribution and History

Apparently these beetles have not been found outside the Hawaiian Islands, though they are pretty well distributed within the group. We have a number of records of specimens taken on Maui and Hawaii, and they are certainly abundant on Oahu,—probably a little investigation will disclose them on all the islands, for they are an insect easily transferred in shipping.

The earliest record that we have been able to locate is the description of this beetle by Sharp[1] in which he gives the note "Found in Houses in Honolulu." We are surprised, after observing the depredations of this pest, that more references to it can not be located.

Life-History

A study of the life-history was comparatively easy, since the several stages advanced so rapidly under our tropical conditions. In one instance the whole life cycle required only 150 days. It is interesting to compare this record with that of the closely related *Attagenus piceus* of the United States, which Chittenden found took two years for its development from egg to beetle.

Newly-emerged beetles were confined in a glass dish and supplied with some of the woolen cloth, which had been injured by the larvæ. A number of dead roaches and flies were also placed in the dish to insure sufficient food. After twelve days, mating was observed, but it was thirty-six days before the first eggs and newly hatched larvæ were discovered.

Egg.—The creamy-white of the eggs made it difficult to discover them on the cloth which was the same color, but after they were once observed it was rather easy to locate them with a lens. It was found that newly-laid eggs required an incubation period of about three days. In form the eggs are broadly oval; being about 1 mm. wide by 2 mm. long; the shape varying considerably, since they are rather soft.

Larva.—The newly hatched larvæ are noticeably large, compared with the eggs from which they emerge: see Figure 18, 1 and 2, which are drawn to the same scale.

[1] Trans. Royal Dublin Soc., vol. III, ser. II, 1885, p. 147.

The larvæ were supplied with the same kind of food as noted above for the adults. They showed a great fondness for dried insects, but in no case were they observed to eat their own cast skins, even when no other food was supplied them. Pupæ, however, were sometimes eaten if left in the same dish with the larvæ.

As is common with all Dermestids, there is great variation in the larval period. While the majority run through rather close together, there are always a few, which for some unaccountable reason, are exceedingly slow, even when all observable conditions are the same. Typical development may be stated as follows: First instar, 10 to 12 days; second instar, 16 to 18 days; third instar, 14 to 16 days; fourth instar, 15 to 35 days; fifth instar, 12 to 15 days; sixth instar, 17 to 25 days; seventh instar, 33 to 46 days. It is interesting to compare with this a specimen, almost full grown when taken from the trunk a year ago. It has hardly increased in size, though abundantly supplied with food; and has molted five times, at the following intervals; 47–37–74–68–87 days. Another individual, after feeding for two years upon dried insects, and molting fifteen times, showed no growth.

Pupa.—Pupation takes place wherever the larvæ are feeding,—the last larval skin being shed. The pupal stage lasts from 12 to 14 days.

Adult.—The beetles, apparently feed upon the same substances as the larvæ, for our specimens reproduced abundantly and lived for a period of 40 to 52 days. As is characteristic of Dermestids, they are able to live, generation after generation, without a sign of moisture, upon absolutely dry food material, and apparently do well even when sealed up away from the air.

TECHNICAL DESCRIPTION

The Larva.—No description of this stage has been published. Figure 3 shows the general appearance of a full-grown larva. The ground color is very dark brown, and the vestiture slightly lighter. The dorsal surface is covered with short, appressed hairs, and very sparsely interspersed with coarser erect hair arranged in a transverse row along the caudal border of each segment. The lateral tufts of the thorax are slightly denser than on abdomen, where the few hairs are somewhat longer; the caudal segment terminates in a pencil of long, delicate hairs of somewhat lighter shade. Compact, suberect hairs of head, and the legs rufus. The ventral surface is whitish, the abdominal region covered with blackish, appressed hairs, denser on the terminal segments. Length of full grown larvæ about 10 mm.

The Pupa.—No description has been given of this stage either, though the pupa, which is creamy white, and covered with a fulvous pubescens, resembles rather closely that of *Attagenus piceus*. The same peculiar openings are located along the medium dorsal region of the abdomen. (See Figure 18, 3 and 4.) Each of these openings is bordered by two chitinous plates, the cephalic one bearing minute teeth. The function of these openings is hard to determine, though it has been observed that the margins will quickly close upon and grip any object inserted into them. Pupa somewhat longer than adult, measuring 6 mm.

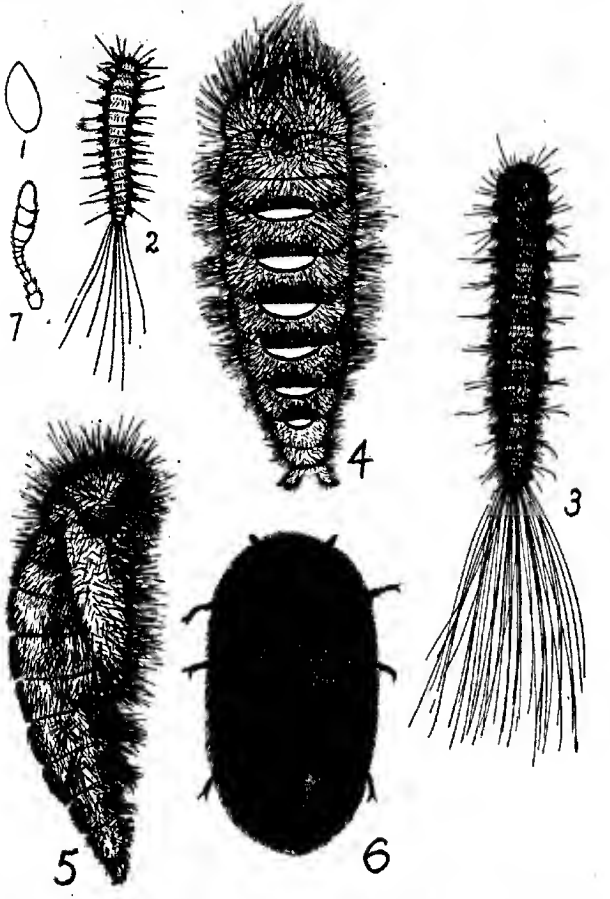

Fig. 18. *Attagenus plebius*. 1. Egg, x14. 2. Newly hatched larva x14. 3. Full grown larva, x10. 4. Dorsal view of the Pupa, x10. 5. Lateral view of Pupa, x10. Dorsal view of beetle, x10. 7. Antenna.

THE BEETLE.—It may be well to quote here from the original description since that publication is not easily accessible.

"Sat elongatus, opacus, dense pubescens, niger, antennis pedibusque rufis, capite, thorace, elytrorumque fascia angusta, angulata, subbasali pubescentiæ pallidæ. Long. 4–4½ mm. ♀ ♀"

"Similar in size, form and appearance to the European *A. verbasci*, but with only one pale band on the elytra. The specimens described are probably of the female sex, and have the antennæ short, the club three-jointed, and in length equal to the

five or six preceding joints together; the apical joint but little longer than the tenth; thorax densely pubescent, so that its punctation is concealed; the pubescence pale, but in certain light, appearing dark on middle parts, owing apparently to an admixture of spots or patches of black pubescence; elytra not quite so densely pubescent as the thorax; the pubescence black, but there is a conspicuous band of cinereous pubescence near the base which at the suture is strongly angulated in front, so as to approach rather near to the scutellum; legs entirely red."

Relation to Light

Both the larvæ and the mating beetles show a decided negative relation to light. The latter, however, fly to the windows after ovipositing. The beetles may be collected in this way but it is of little avail, since the eggs have already been deposited in closets or trunks, etc.

Control Measures

Carbon bisulphide was found to be effective for the destruction of both beetles and larvæ in the trunks, but apparently the eggs were not killed by it, for young larvæ were discovered on some of the contents two weeks later. After a second treatment with the carbon bisulphide we found no further signs of the insects. To insure the contents against further attack they were given a liberal supply of flake naphthaline, scattered between the various garments. This treatment lasts for a year or more if the trunks are not opened, and no beetles will enter while the naphthaline is present.

Treatment of clothing in closets of open houses, such as we have in the tropics, is a more difficult matter. Fumigation is often out of the question, and if moth-balls are used they require frequent renewal. Fortunately, however, the clothing which is used frequently is not subject to injury. Very satisfactory moth-proof bags are on the market, and these come in such sizes that entire garments may be suspended in them.

This paper was discussed by A. W. Morrill, R. W. Doane, E. O. Essig and others.

Chairman A. W. Morrill: The next paper by Mr. G. F. Mozenette will be read by the secretary.

THE CYCLAMEN MITE, TARSONEMUS PALLIDUS BANKS, AND METHODS FOR ITS CONTROL

By G. F. Mozenette, *Corvallis, Oregon*

(Paper withdrawn for publication elsewhere)

Chairman A. W. Morrill: The next paper, by Prof. A. L. Lovett, will be read by the secretary.

ARSENIC AS AN INSECTICIDE

By A. L. Lovett, *Entomologist*, and R. H. Robinson, *Assistant Chemist, Oregon Agricultural Experiment Station*

From the standpoint of physical chemistry, it is generally known that many solid materials have the power of adsorbing certain ions from solutions. By the use of the term "adsorption" we mean the existence of a difference in the concentration of a film surrounding a solid and the concentration of the liquid which bathes this solid. In other words, the solid has a high retaining power for the material in solution. Since, therefore, it is the arsenic of the arsenical sprays that is the active element, if some inert material could be easily obtained in considerable quantities at a reasonable cost, which would adsorb sufficient arsenic to make the substance efficient as a spray, it would be worthy of consideration as an insecticide.

Acting on this hypothesis, a series of experiments were outlined, using lamp black and fuller's earth as adsorbants of arsenic from a water solution of arsenic acid. No determination of the amount of arsenic adsorbed by the lamp black and fuller's earth was made, but water solutions of arsenic acid were prepared from the chemically pure arsenic oxide and to various solutions of different concentrations of arsenic, the carbon black and fuller's earth were added as indicated in the tables. The materials were tested first as to their toxicity for insects, second for burn on apple foliage in the field.

Experiment A

April 9, 1916. Uniform samples of clean, unsprayed apple foliage were used. These were placed in large vials of water in the laboratory and thoroughly and uniformly covered with the spray solution. The foliage was allowed to dry for a period of six hours, after applying the spray, and approximately 500 small tent caterpillars (*M. pluvialis*) were introduced on each.

The materials were prepared according to the following proportions:

No. 1. As_2O_5 at the rate of 5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 5 grams to 300 c.c. H_2O.

No. 2. As_2O_5 at the rate of 5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 5 grams to 300 c.c H_2O.

The foliage of No. 1 was absolutely covered with a thick, heavy coat of black. The caterpillars were restless and dissatisfied, and piled up and suspended themselves from the foliage by webs. Eventually they covered over most of the foliage closely with a fine web. The worms on No. 2 seemed more contented.

But little, if any feeding took place for the first 12 hours; from that time on feeding was general, but restricted. On the morning of April 11, a period of 48 hours, practically all the caterpillars were dead. The amount of foliage devoured was about equal on the two materials and comparatively slight on either. The foliage showed small scattering spots of burn. By April 13, four days after spraying, the foliage on both No. 1 and No. 2 was burned to a crisp.

Experiment B

May 6, 1916. Sprayed apple foliage in laboratory with the following materials, allowed to dry and introduced approximately 1,000 half-grown caterpillars on each.

No. 1. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 2 grams to 300 c.c H_2O.

No. 2. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 1 gram to 300 c.c. H_2O.

No. 3. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 2 grams to 300 c.c. H_2O.

No. 4. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 1 gram to 300 c.c. H_2O.

As in Experiment A, the caterpillars were restless and refused to eat for a few hours, but soon commenced to feed sparingly.

Table Showing Rate of Kill of Materials

Material	Number Dead			
	May 7	May 8	May 9	Total
No. 1	40	252	454	746
No. 2	21	232	373	626
No. 3	37	531	Practically all dead	568
No. 4	24	259	257	540

Comparatively speaking, but little foliage was devoured. Most of the caterpillars which remained on the foliage were decidedly sick by the morning of May 8, and there was no feeding on the 9th. A number of caterpillars from each series dropped from the foliage without feeding and crawled away, which accounts for the small totals compared with the numbers introduced. The foliage showed small scattered spots of burn the afternoon of May 8. May 10, the burn had spread somewhat, though by no means as general as in Experiment A.

These materials might be termed rapid killers; in comparison with acid lead arsenate and calcium arsenate they apparently have a higher toxicity.[1] However, at these dilutions there is too severe a burn for field use.

[1]Lead arsenate and calcium arsenate tests for toxicity were carried on at the same time.

Experiment C.—Test of Materials in the Field

June 8, 1916. Sprayed the foliage of young apple trees in the field; foliage was thoroughly saturated with the different materials. The test was for burning only, as caterpillars were not available in sufficient numbers to warrant a check being made.

No. 1. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus lamp black at the rate of 2 grams to 300 c.c. H_2O.

No. 2. As_2O_5 at the rate of 1 gram to 1000 c.c. H_2O, plus lamp black at the rate of 1 gram to 300 c.c. H_2O.

No. 3. As_2O_5 at the rate of .75 gram to 1000 c.c. H_2O, plus lamp black at the rate of 2 grams to 300 c.c. H_2O.

No. 4. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 2 grams to 300 c.c. H_2O.

No. 5. As_2O_5 at the rate of 1 gram to 1000 c.c. H_2O, plus fuller's earth at the rate of 1 gram to 300 c.c. H_2O.

No. 6. As_2O_5 at the rate of .75 grams to 1000 c.c. H_2O, plus fuller's earth at the rate of 2 grams to 300 c.c. H_2O.

No. 7. As_2O_5 at the rate of 1.5 grams to 1000 c.c. H_2O.

No. 8. As_2O_5 at the rate of .75 gram to 1000 c.c. H_2O.

Report on burn; weather throughout fairly cool and cloudy, with showers.

June 10. Forty-eight hours after applying spray:

Lamp Black Series
- No. 1. Burn general and severe.
- No. 2. Burn general and severe, though probably a little less intense than No. 1.
- No. 3. Burn general.

Fuller's Earth Series
- No. 4. Burn general, though scattered and not particularly severe.
- No. 5. Burn slight.
- No. 6. Burn negligible, only trace.

- No. 7. Burn general, fairly severe.
- No. 8. Burn same appearance and about equal to No. 4.

June 11. Three days after spraying:

Lamp Black Series
- No. 1. Burn spreading, very bad.
- No. 2. Burn spreading, severe.
- No. 3. Burn spreading, severe.

Fuller's Earth Series
- No. 4. Slightly worse than yesterday.
- No. 5. Same as yesterday.
- No. 6. Same as yesterday.

- No. 7. Burn increasing.
- No. 8. Burn increasing.

June 24. Sixteen days after spraying:

Lamp Black Series
- No. 1. Foliage burned until about all has dropped.
- No. 2. Foliage burned until about all has dropped.
- No. 3. Foliage burned, very bad.

Fuller's Earth Series
- No. 4. Burn about same as on June 11, while probably too pronounced for general spray work, is not really serious.
- No. 5. Slightly more than on 11th, but not really bad.
- No. 6. O. K., burn comparatively slight.
- No. 7. Burnt to a crisp.
- No. 8. Burnt to a crisp.

Conclusions

Under field conditions lamp black is not practical, the black color probably absorbs heat and increases the burn. That the presence of an adsorbant has possibilities is clearly shown in a comparative study of the burn between Nos. 5 and 7, and between Nos. 6 and 8. Nos. 5 and 6, having fuller's earth as an adsorbent, giving comparatively little burn. Nos. 7 and 8, with the same dilution of arsenic, but without an adsorbent, burned all the foliage absolutely to a crisp. Conclusions based on one season's observations, both as to toxicity for insects and as to amount of burn indicate that there are possibilities in the use of adsorbents with arsenic and further trials are planned on a larger scale for the coming season. Estimates based on insufficient data would indicate that if such a material may be used commercially it will reduce the cost of arsenical sprays about two-fifths.

Meeting adjourned until 2 p. m. the following day.

Meeting called to order by Chairman A. W. Morrill at 2 p. m., Friday, April 6, 1917.

Chairman A. W. Morrill: The first on the program is a symposium on mail shipments of plants and plant products. This will be opened by myself and then a general discussion will follow.

Chairman Morrill: I have long held the view that postal shipments are proportionally more dangerous as regards the transmission of all plant pests than shipments by express or freight. The results of the first year's experience of parcel post shipments in Arizona tend to confirm this view. Altogether we inspected 543 of these shipments and found that 4.4 per cent contained infested or diseased plants. During the same period 2,432 freight and express shipments of plants were inspected with the result that only 2.5 per cent were found to contain infested or diseased plants. The pests found in parcel post shipments were fully as important on the average as the pests found in freight and express shipments. During the nine months' inspection of parcel post shipments the following pests were found by our inspectors: Soft brown scale (*Coccus hesperidum*) 1 shipment; purple scale (*Lepidosaphes beckii*) 1 shipment; rose scale (*Aulacaspis rosae*) 1 shipment; undetermined scales (immature) 3 shipments; plant lice

(undetermined) 6 shipments; thrips (undetermined) 3 shipments; red spider (*Tetranychus bimaculatus*) 4 shipments; citrus white fly (*Dialeurodes citri*) 2 shipments; moth larva (undetermined) 1 shipment; tortoise shell beetle larvæ on sweet potato (Cassida sp.) 1 shipment; crown gall (*Bacterium tumefaciens*) 3 shipments.

One parcel post shipment contained citrus trees from a section against which a quarantine is maintained and one contained currants and gooseberries from the district covered by the Federal Horticultural Board's request to nurseries dated March 22, 1916, to discontinue shipments into certain Western territory owing to the danger of transmitting white pine blister rust.

I am particularly apprehensive of the danger of the pink bollworm of cotton becoming established in this country and afterwards spread beyond hope of eradication by means of parcel post shipments of cottonseed. I have reason to believe that a good many plant shipments coming into the State of Arizona by parcel post have not been held for inspection by the postmasters. The particular difficulty in maintaining an efficient inspection service for parcel post shipments of plants lies in the lack of personal responsibility of the postoffice employees for the packages which pass through their hands. It has been our experience that whenever any unnecessary delay in delivery after inspection or failure to hold a plant shipment for inspection comes to our attention, it is impossible to place the responsibility among the postoffice employees at the offices concerned. Freight and express shipments however are all handled in such a manner that it is almost invariably possible to trace the blame for irregularities to the proper sources. I believe that parcel post shipments of plants are extremely dangerous to the fruit growing and farming interests of the country and I hope that the time will soon come when all shipments of plants by parcel post will be prohibited as has already been done with respect to mail importations from foreign countries.

The discussion following was general and nearly every member present participated.

CHAIRMAN A. W. MORRILL: The next paper will be read by W. M. Davidson.

The Division of Entomology, North Carolina Department of Agriculture, has entered into agreement with the Bureau of Plant Industry whereby it is planned to employ a man, suitable to both parties, for one or more months' scouting work in the white pine region of the state in search of the pine blister rust disease,—this to be supplemented by special attention to five-leaved pines and Ribes in the nursery inspection work the coming summer. The blister rust disease is not now known to be present in North Carolina.

THE REDDISH-BROWN PLUM APHIS (RHOPALOSIPHUM NYMPHEÆ LINN.)[1]

By W. M. Davidson, *Deciduous Fruit Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture, Sacramento, Cal.*

Distributed in many of the plum and prune districts of California is a plump reddish-brown aphid. This aphis is generally confined to a few trees in an orchard and occasionally infests apricots and almonds. It attacks plums of the *domestica* type along with the Mealy Plum Aphis (*Hyalopterus arundinis* Fabr.), and those of the Asiatic type along with *Aphis cardui* L. In the East it also occasionally infests peaches.

The insect is apparently of European origin and was known to Linnæus. Well-known to later European and American entomologists, it has been recorded from many parts of Europe and from Maine, New York, Maryland, District of Columbia, Virginia, Pennsylvania, Nebraska, Illinois, Iowa, Colorado and California and is probably distributed throughout the United States. It also occurs in Ontario and Japan.

The species is of especial interest in that it is double-hosted, spending the winter and spring on fruit trees and the summer and early fall on a large variety of water plants, leading on them a semi-aquatic existence. In California summer forms have been recorded from *Polygonum*, *Typha*, and an unidentified pondweed, elsewhere they have occurred among others on water-lily (*Nymphea*), pondweed (*Potamogeton*), Calla and water-plantain (*Alisma*).

Biology and Habits

The stem mothers hatch from winter eggs unusually early in the season, sometimes before the buds of the trees perceptibly swell. In 1916 at Walnut Creek, Cal., hatching began about February 10, on Myrobalan plums, and the earliest aphids matured before February 26. The year following at Sacramento eggs hatched as early as February 15 on seedlings whose buds were swelling, and the aphids matured March 6. Hatching on French prunes occurs at about the time the buds swell perceptibly, the early stem mothers maturing at the time of full bloom. Eggs continue to hatch for two or three weeks, the young stem mothers exhibiting a gregarious tendency. The second generation aphids mature about as early as the stem mothers of the Mealy Plum Aphis (*Hyalopterus arundinis* Fabr.), roughly between March 20 and April 15. The spring forms feed chiefly on the tender

[1] Published with the permission of the Secretary of Agriculture.

stems, and later on the leaf and fruit petioles and during April multiply rapidly. Winged forms appear first the second week in April and may be found until July. The colonies decline throughout May and June, both through the production of winged migrants and through the increasing activity of natural enemies.

Summer colonies are found from May to October and are often very large, the individuals being very prolific. Natural enemies again exact heavy toll.

Fall migrants are produced from the middle of October to early December, the majority during the first half of this period. In 1915 at Walnut Creek, Cal., these began to arrive on the winter host October 25, in the following year on October 20. The fall migrants feed on twigs and petioles and deposit the sexed females. Winged males arrive while the females are growing and settle down on the twigs beside them. After a development period of about 20 days the females mature, copulation occurs and shortly after the females place winter eggs in the axils of the buds of the following year. The egg is rather elongate, bare, at first shining green, in a few days turning jet black.

This aphis is preëminently a twig-feeder and the fact that the stem mothers hatch so early and feed exposed points to an easy control should the species ever become of sufficient economic importance to warrant combative measures. Even on many of the summer hosts the twigs and flower stalks are preferred to the leaves.

Recognition Characters

General Color.—Reddish-brown varying to dark olive and dark greenish-brown. Newly-hatched stem mothers are green, soon changing to a dark slate-colored hue, lightly dusted with gray pruinose meal. Aphids of the second generation are yellowish-brown when born, reddish-brown in later stages. Sexual females crimson.

The head and abdomen of the pupa bear white pulverulence.

In the winged forms the head, thoracic lobes, scutellum and sterna are shining black, prothorax brown with yellowish sutures. The stigma and insertions of the wings are yellowish gray, the veins brown; the first and second discoidals thicker than the other veins. Many individuals have a series of lateral sub-circular brown areas, and besides these the males have brown cross-bands on the abdomen.

The base of the third antennal joint, basal beak joints, extreme base of femora, basal half to three quarters of tibiæ are yellowish-gray, elsewhere the appendages are dark gray, dark brown or black. Cauda gray, cornicles brownish-black with base paler.

Structure.—Antennæ placed on short frontal tubercles, shorter than the body (except in the male); joint III about four-fifths as long as the spur of joint VI, but in some instances III is but three-fifths as long as spur and again they are sub-equal; in apterous forms there are no sensoria except the usual terminal on joints V and VI; in the winged spring migrants joint III has from 17 to 22 circular sensoria distributed almost the whole length of the joint and joint IV has from 0 to 3 circular sensoria. In the winged fall migrant the number of sensoria on joint IV varies from 2 to 11, the usual number being 3. The male antenna bears on joint III about 30, on IV about

16, and on V about 12 small circular sensoria arranged irregularly; joint VI having only the usual "terminal" group. The oviparous female bears on her thickened hind tibiæ numerous small circular sensoria.

The beak reaches to or a little beyond the third coxæ. The stigma of the fore-wings is rather elongate, the stigmal vein with a shallow basal curve thence continued almost in a straight line to the margin of the wing. The cornicles are imbricated and club-shaped, constricted about basal third and again less markedly close to the apex, their shape differing according to the form, those of the spring wingless and oviparous female being less clubbed than in the other forms. The cauda is upturned in nature, about two-fifths as long as the cornicles, its apical portion quite noticeably narrowed.

A normal armature of hairs is found in all forms.

Lateral tubercles are present on the pro-thorax in all forms; on abdominal segments 1 to 7 inclusive in the winged, on abdominal segments 1 and 7 only in the wingless forms.

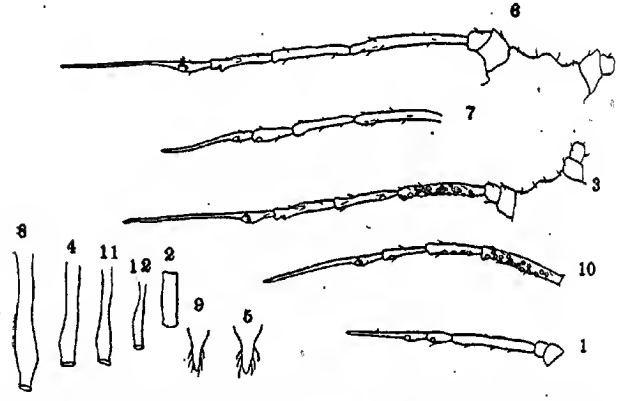

Fig. 19. *Rhopalosiphum nymphææ* Linn.: Fig. 1, stem mother, antenna; 2, stem mother, cornicle; 3, spring migrant, head and antenna; 4, spring migrant, cornicle; 5, spring migrant, style (cauda); 6, summer apterous, head and antenna; 7, summer apterous, antenna (apical segments) from smaller individual; 8, summer apterous, cornicle; 9, summer apterous, style; 10, fall migrant, antenna apical segments; 11, fall migrant, cornicle; 12, male, cornicle. All drawn to same scale.

COMPARATIVE MEASUREMENTS (MM.)

Form	Antennæ lengths						Cornicles length	Cauda length	Beak length	Wing length
	III	IV	V		VI					
			base	spur	base	spur				
Stem mother	*.30 to .33	.095 to .105	.08 to .10	.20 to .23			.20 to .22	.13 to .15	.52	—
Spring apterous generation (Plum)	.20	.18 to .225	.145 to .195		.095 to .125	.29 to .325	.29 to .32	.17 to .18	.52	—
Spring migrant	.33 to .44	.20 to .27	.20 to .24		.105 to .120	.38 to .46	.30 to .39	.15 to .18	.60 to .62	3.10 to 4.0
Summer apterous form (Summer hosts)	.28 to .39	.22 to .27	.18 to .22		.11 to .13	.36 to .39	.37 to .50	.15 to .17	.60 to .63	—
Fall migrant	.32 to .38	.22 to .29	.18 to .22		.09 to .14	.37 to .48	.30 to .37	.15	.65	3.05 to 3.4
Male	.33 to .39	.24 to .28	.19 to .23		.09 to .11	.35 to .46	.22 to .28	.09 to .11	.51	2.35 to 2.72

*Joint III evidently represents combined III and IV of later forms.

The discussion following was by R. W. Doane, H. E. Burke and E. O. Essig.

CHAIRMAN A. W. MORRILL: The next paper will be presented by Mr. Geo. P. Gray.

LABORATORY AND FIELD TESTS OF CALIFORNIA PETROLEUM INSECTICIDES

By GEO. P. GRAY, *Berkeley, Cal.*, and E. R. DEONG, *Davis, Cal.*

(Withdrawn for publication elsewhere)

This paper was discussed by A. W. Morrill and other members of the house.

CHAIRMAN A. W. MORRILL: The next paper will be presented by Mr. Stanley B. Freeborn.

THE RICE FIELDS AS A FACTOR IN THE CONTROL OF MALARIA

By STANLEY B. FREEBORN, *Instructor in Entomology, University of California*

The introduction of rice culture into the Sacramento and San Joaquin Valleys of California has called forth much comment as to its possible influence upon the increase and control of malaria which is already endemic in both valleys. Rice was first grown commercially in California in 1912 when 1,400 acres were planted at Biggs in the Sacramento Valley. The acreage has increased at the rate of over 100 per cent a year since that time until 1916 saw about 75,000 acres under cultivation. The industry is an exceedingly fortunate one owing to the fact that land rendered useless by previous cropping or unfit for other crops on account of faulty texture has been used for rice, thus adding materially to the state in wealth.

The cultivation of rice demands that the entire acreage be flooded to the depth of four or five inches with water stagnant or in a gentle current for a period varying from 145 to 160 days beginning about June first.

Theoretically, at least, these large bodies of standing water, well aerated by a gradual addition of water and the presence of the growing rice, should form ideal breeding places for malaria-bearing mosquitoes. However, there is a deep grounded belief among those who deny the ability of the rice fields to produce mosquitoes, that there is an "essential something" in the rice fields that prevents mosquito breeding. This "essential something" is explained by another mystery,—the ecological factors governing the habitat of the different species of mosquitoes. Just as salmon, brook-trout, and steel-heads choose different breeding grounds, so the different species of anophelines invariably deposit their eggs in locations where a given set of determining factors are present. Some, it is true, have a wide range of selection but the majority are limited to very definite locations. For example, *A. malefactor*, a tropical anopheline, breeds almost exclusively in hollow tree trunks while *A. ludlowii* is limited to brackish or salt tide water. Again *A. febrifer*, a Philippine malaria carrier finds its ideal habitat at the edge of running streams and is seldom present in stagnant pools as is the case with our domestic anophelines. The statement that California rice fields will not furnish breeding grounds for malaria-bearing mosquitoes is based solely on the empirical application of the knowledge that in certain parts of the world, the hypersusceptible anophelines of the district do not find their natural breeding places in the rice fields.

Barber has shown that the rice areas of the Philippines are singularly free from malaria due to the fact that the typical rice field anopheline, *A. rossi*, is only a weak and somewhat doubtful carrier of malaria while the intensive carrier, *A. febrifer*, is a stream breeder whose breeding places are destroyed with the introduction of rice paddies. He follows these remarks with the statement that " . . . in some parts of the Philippines the further development of rice culture may result in the diminution of malaria."

Watson, writing of malaria conditions in the Federated Malay States, comments on the absence of malaria in the rice districts and its abundance in the hill country and suggests rice culture as an anti-malarial measure.

Kendrick, working in central India, observed that the rice districts on the broad open plains were practically free from malaria but that when shade such as that afforded at the edge of the jungles was present the species of anopheles changed and malaria was present. In all of these instances of malaria free rice districts, the anophelines present lacked the ability to transmit malaria or were relatively weak carriers.

From these findings of men who have dealt with the problem in various countries and under different conditions, the only safe deduction that can be made is the fact that each district requires separate investigation regardless of apparent similarity. The Californian problem can not be settled by Indian or Philippine investigations or even by those under way in our own southern states.

In order to determine, therefore, the relative importance of the rice field mosquitoes as a factor in malaria control, it is necessary to ascertain (1) what anophelines breed in the rice fields and the pools adjacent to and caused by them, (2) their susceptibility as malaria carriers, and (3) their relative abundance.

In the Sacramento Valley rice fields two anophelines find reasonably satisfactory breeding grounds judging from the number of larvæ taken. *Anopheles occidentalis* D. & K. and *Anopheles pseudopunctipennis* Theob. are both present in large numbers, making up about one half the mosquito population of the district. Probably 70 to 80 per cent of these two species find their breeding places in the pools attendant to the rice fields and caused by seepage, overflow and faulty water regulation. The other 20 to 30 per cent breed in the rice fields proper in the shallow water near the contour checks.

A. occidentalis is a recently named species which was previously considered to be *A. quadrimaculatus*, the principal eastern and southern malaria-carrier. Nearly a thousand specimens of *A. occidentalis* in our collection show all stages of resemblance to *A. quadrimaculatus* from those fairly well defined to those that are practically identical

with the latter. No experimental work has been done to show that *A. occidentalis* is susceptible to the parasite of malaria but since it is one of only two anophelines that are found in highly malarial districts and the other,—*A. pseudopunctipennis*, is only slightly susceptible, it seems reasonable to believe that it is the chief carrier. To this circumstantial evidence might be added the additional reminder of its close connection and perhaps synonomy with *A. quadrimaculatus*, a proven carrier of malaria in many parts of the United States.

Beyer and his associates stated that *A. quadrimaculatus* could be infected with the tertian and quartan types of malaria but not with estivo-autumnal. However, Hirshberg succeeded in infecting eight out of 48 specimens of *A. quadrimaculatus* that were allowed to feed on a volunteer suffering with the estivo-autumnal fever. Von Ezdorf, in a later paper, states conclusively that *A. quadrimaculatus* is susceptible to all three types of malaria.

A. pseudopunctipennis has always been looked upon doubtfully as a malaria carrier. Darling succeeded in infecting four out of 27 of this species with estivo-autumnal parasites, but a very small series of experiments with the parasites of the tertian and the quartan types of fever proved negative.

The apparent contradictions of the different findings regarding the infectivity of the same species of mosquito, is by no means limited to those above stated. The same type of contradictions is prevalent throughout the literature of infectivity experiments. This may be due in some cases to faulty technique, confused nomenclature, or the failure to state what type of malaria parasites were used for the experiment, for different types of malaria are carried by different species of *Anopheles*. Many times mosquitoes have been listed as non-malaria carriers on the basis of experiments with one type of malaria although they were the most important carrier of another type. Mitzmain has proved this in showing that *A. punctipennis* is a strong carrier of tertian fever but absolutely negative to estivo-autumnal. Another source of error seems to be in the failure to consider ecological factors. Some species seem capable of carrying malaria in one district while repeated attempts to infect them in other portions of the country with the same type of malaria invariably result negatively. Majoribanks states that *A. listoni* is the chief carrier in parts of Bengal and although occurring in large numbers in western India has never been found infected despite the fact that malaria is endemic there.

Considering both the circumstantial and experimental aspects of the California problem, I feel that we can safely say that in the rice districts *A. occidentalis* is the important carrier with perhaps a few scattered infections due to the agency of *A. pseudopunctipennis*.

These two mosquitoes breed in the rice fields close to the contour checks which wind about through the fields to hold the water at the different levels, their abundance depending largely on the character of the rice stand. A heavy and uniform stand of rice, growing well up to the checks, produces relatively few mosquitoes while a sparse stand with irregular growth at the checks generally breeds anophelines in large numbers. Far more important than the rice fields proper, however, are the overflow pools of surplus water. These vary in size from small wayside pools to vast water-soaked sloughs that lack the natural drainage to keep them dry. These bodies of water, both large and small, breed enormous numbers of mosquitoes and are entirely unnecessary. Careful construction of the irrigation ditches together with an intelligent and economical use of water would entirely eliminate them in a majority of cases.

The irrigation of the rice fields does not begin until May. The mosquitoes, however, begin active breeding in March and April, utilizing neglected pools of standing water. Again after the water is drawn from the rice fields in October, the mosquitoes continue to breed actively until the latter part of November, again utilizing neglected and useless pools. If, therefore, all possible breeding pools could be controlled before and after the rice season as well as the outside pools that occur as results of rice cultivation during the season, the mosquito population would be so considerably reduced that the number breeding in the rice fields proper would be almost negligible.

The best agricultural methods demand that the land used for rice and the adjacent territory be as nearly dry as possible before the crop is planted. Again the irrigating water should be on the fields only just long enough to mature the crop. As the rice approaches maturity every detail should be undertaken to ensure immediate drainage away from the fields at the moment that the crop matures. The fields should then remain dry until they are naturally irrigated by the winter rains. Thus it will be seen that optimum agricultural methods coincide with optimum mosquito control measures and when the industry has become scientifically standardized the mosquito question will be controlled automatically to a large extent.

Unfortunately, a large percentage of the rice cultivation is carried on by tenant farmers whose only vision is to reap the speediest and most lucrative returns. The result has been as might be expected, the irrigation ditches are badly maintained, the land is robbed of its chemical constituents by poor agricultural methods and the profligate use of water. Perhaps the most striking phase is the living conditions of the workmen. The labor is transient and many of the shelters are mere shacks lacking any attempt to exclude mosquitoes with the result

that infected laborers rapidly spread their infection throughout the district by means of the numerous mosquitoes.

The control of those mosquitoes that breed in the rice fields proper is an extremely difficult matter. Larvicides that are efficient in mosquito control, such as oil, salt, etc., are detrimental to the rice. Fish are not successful owing to the difficulty in keeping the fields stocked and their inability to feed in the shallow water inhabited by the mosquitoes. Dragonflies as adults may be looked upon as a check but not as a control. The dragonfly larvæ, even in the presence of an abundant supply of mosquito larvæ and pupæ, prefer cannabalism.

Theoretically, malaria can be controlled in two ways. If everyone in a malarial district could be cured by means of quinine treatment the mosquitoes would have no point at which to become infected or if everyone would take a daily prophylactic dose of quinine, the chances of infection even though bitten by an infected mosquito would be materially lessened and the death of the last infected mosquito would see the community free from malaria. Secondly, if all malaria-bearing mosquitoes were eliminated there would remain no transmitting agency to convey the disease from the sick to the well and again malaria would disappear from the community with the recovery of the cases infected at the time of the elimination.

Experience in different lines of preventive medicine points out the difficulty of administration of universal quinine treatment. In this country of personal liberty it would be practically impossible to force any such measure upon the people no matter how beneficial it might eventually be. On the other hand, those who have had experience with anti-mosquito campaigns know the difficulties attendant to nominal *control*, to say nothing of the *elimination* of mosquitoes from any given district.

The logical control of malaria in the rice districts of California rests in the careful application of a combination of these two methods,—zealous anti-mosquito campaigns together with careful quinine treatment or prophylaxis.

1. The rice field becomes an economic factor in the control of malaria in endemic localities when they offer breeding grounds to large numbers of anopheline mosquitoes that are capable of transmitting the malaria parasites. This is true in the California rice fields.

2. The pools of standing water outside the rice fields proper, but owing their existence to faulty agricultural methods of the rice growers, are far more important than the rice fields proper.

3. The control of breeding places outside the rice fields before, after and during the rice season combined with an application of those methods of rice cultivation that are recognized as agriculturally sound would substantially control the mosquitoes.

4. Larvicides or predaceous animals are of little use in the rice fields.

5. Organized quinine prophylaxis and treatment together with anti-mosquito precautions would decrease materially the incidence of malaria.

Bibliography

Barber, M. A.; Raquel, Alfonso; Guzman, Ariston; and Rosa, A. P. Malaria in the Philippine Islands. Phil. Jour. of Sci., vol. X, No. 3, Sec. B, pp. 177–247.

Beyer, G. E.; Pothier, O. L.; Couret, M.; and Lemann, I. I. Bionomics, experimental investigations with *Bacillus sanarelli* and experimental investigations with malaria in connection with the mosquitoes of New Orleans. Report of the Mosquito Commission to the Orleans Parish Med. Soc. New Orleans Med. & Surg. Jour., vol. 54, pp. 419–480.

Darling, S. T. Studies in relation to Malaria. Reprint of Dept. of Sanitation, Isthmian Canal Commission.

Herms, W. B. Medical and Veterinary Entomology. Macmillan Company, 1915.

Herschberg, L. K. An *Anopheles* mosquito which does not transmit malaria. Bull. Johns Hopkins Hospital, vol. 15, No. 155, pp. 53–56.

Kendrick, W. H. Malaria and Rice Cultivation. Proc. of All-India San. Conf., Lucknow, vol. IV, pp. 64–70.

Majoribanks, J. L. Report on certain features of malaria in the island of Salsette. Proc. of Third All-India San. Conf., Lucknow, vol. IV, p. 23.

Mitzmain, M. B. The transmission of tertian malaria by *Anopheles punctipennis* Say. U. S. Public Health Reports, vol. 31, No. 19, May 12, 1916.

Von Ezdorf, R. H. Anopheline Surveys. Reprint No. 272, Pub. Health Reports. April 30, 1915.

Watson. Cited by Barber et al., loc. cit.

Chairman A. W. Morrill: It will probably be best to wait and discuss this paper along with the next one which is to be read by Prof. W. B. Herms.

A STATE-WIDE MALARIA-MOSQUITO SURVEY OF CALIFORNIA

By William B. Herms, *Associate Professor of Parasitology, University of California, and Consulting Parasitologist, of the California State Board of Health*

The great state of California, bathed for many miles by the waters of the Pacific Ocean, favored by a semi-tropical climate, well deserves to be called the nation's health resort and playground, but while Burbank has shown how the spine-covered cactus may be made smooth to the touch, and we now have under cultivation many acres of spineless cactus, there still thrives in many parts of the state the festive mosquito, not yet shorn of its beak nor devoid of its ability to transmit malaria. Evidenced by letters in my possession there are some per-

sons who, cognizant of the prevailing dry summer conditions of California, would believe this state largely free from these pestiferous and noxious insects. True it is that the great valleys of California have little or no rainfall during the summer months, hut this very fact implies the necessity for ample water to produce California's vast acreages of agricultural products. This water, supplied by extensive irrigation systems, is one of the important factors in the production of mosquitoes. To this must be added numerous more or less stagnant summer pools, due to our many rapidly receding creeks and streams. Furthermore, water from the melting snows of the Sierras continually flows down the mountain sides and spreads out here and there over the meadows of the foothills. Thus even though there may be little or no rainfall for several months during the summer, there is ample water and in such condition that the breeding of mosquitoes is favored. The fact that California is bounded for many miles by the Pacific Ocean adds many acres of salt marsh to its mosquito-producing areas. Thus the mosquito problem of the state involves both fresh water and salt marsh species.

That malaria has existed in California for at least sixty years is evident from the following quotation from the writings of Edwin Bryant,[1] one time alcalde of San Francisco and an extensive traveller in California in 1846–1847, viz.: "On some portions of the Sacramento and San Joaquin Rivers, where vegetation is rank and decays in the autumn, the malaria produces chills and fever, but generally the attacks are slight and yield easily to medicine" (page 452).

That mosquitoes abounded at that time is evidenced by the following quotation also from Bryant: "By this change we were relieved from the annoyance of mosquitoes, which have troubled us much during the night at our encampment." This quotation is taken from an entry made between the 3rd and 7th of September 1846 while encamped at Sutter's Fort (p. 273).

The first effort on the part of the University of California to assist in the abatement of the mosquito nuisance was made in Marin County in the vicinity of San Rafael at the request of Mrs. George T. Page of the San Rafael Improvement Club. This request is dated April 5, 1903. An investigation was made by Professor C. W. Woodworth and assistants with the result that oil was applied according to recommendations to certain salt marsh areas responsible for the trouble. This was followed by the employment of Mr. A. L. Ashman during the spring and summer of 1904 for the purpose of mosquito abatement.

In March 1904 the Burlingame (San Mateo County) Improvement

[1]Bryant, Edwin, 1848. What I saw in California. D. Appleton & Co., New York, (480 pp.).

Club invited Professor Woodworth to make a similar investigation of the mosquito problem in the vicinity of Burlingame. Professor H. J. Quayle was detailed to organize and conduct the campaign. Here again the main trouble was traceable to the neighboring salt marshes. During the spring and summer of 1905 Quayle, assisted by students from the University of California, waged a systematic anti-mosquito campaign with marked success.[1] Considerable permanent corrective work was undertaken together with a systematic study of the mosquitoes of that vicinity. During the mosquito seasons of 1911 and 1912 a salt marsh mosquito campaign was conducted by the writer with the help of students in the vicinity of Bay point in Contra Costa County under the patronage of the Smith Lumber Company.

The writer first became definitely identified with the mosquito abatement problems of California in December, 1909, when he received a letter from Penryn, Placer County, requesting that an investigation be made of the malaria-mosquito situation in that vicinity. This investigation resulted in organizing a systematic campaign against mosquitoes during the spring and summer of 1910, terminating in a marked reduction of malaria, particularly in school children. This campaign deserves the distinction of being the first organized anti-malaria crusade in the state. The campaign in Penryn had hardly begun when citizens of Oroville, Butte County, requested that a similar campaign be organized there. These two campaigns are described in detail in the writer's book on "Malaria,—Cause and Control."[2]

The movement spread rapidly so that within the following two years crusades against malaria-bearing mosquitoes had been organized in a number of localities from Bakersfield in Kern County to Los Molinos in Tehama County.[3] One of the chief obstacles from the very beginning has been the matter of securing adequate funds to carry out an efficient crusade. The expenses had thus far been largely borne by a few public-spirited citizens. Hence very early in the work a plan was sought whereby funds might be secured on a more equitable basis, with the result that finally, after several failures, an act of the legislature was approved by the governor on May 29, 1915, known as the "Mosquito Abatement District Act."

This act provides for the formation, government, operation and dissolution of districts, to facilitate the extermination of mosquitoes,

[1]Quayle, H. J., 1906. Mosquito Control. University of California Agric. Exp. Sta. Bulletin No. 178 (55 pp.).

[2]Herms, W. B., 1913. Malaria,—Cause and Control. XI+163 pp. Macmillan Company, New York.

[3]Herms, W. B., 1915. Successful Methods of Attack on Malaria in California. California State Journal of Medicine, vol. XIII, No. 5, pp. 185–189.

flies and other insects; and to provide for the assessment, levy, collection and disbursement of taxes therein. It provides that such tax must not be greater than sufficient to raise the amount estimated by the board of trustees of the district, appointed by the county supervisors, and must not be in excess of ten cents on each one hundred dollars of taxable property in such district.

The first district to be organized under the new law was the San Mateo District, the second being Marin County District No. 1, both involving salt marsh areas. These two districts are now in charge of Mr. N. M. Stover, a graduate of the University of California. A second salt marsh district has been organized in San Mateo County, known as the Pulgas District. The first inland district to be organized involving fresh water mosquitoes of the malaria-bearing type was at Bakersfield,—the Doctor Morris District. Oroville (Butte County) has a well organized district while the Los Molinos District (Tehama County) is ready for operation and Riverside (Riverside County) and Yolo County are now in process of formation.

The act makes it possible to include both incorporated and unincorporated territory or portions of both in the same district, thus protecting communities which draw their supply of mosquitoes very largely from the outskirts which may be outside the corporate limits.

Fourteen species of mosquitoes for California were listed by Quayle[1] in 1906, viz.: *Anopheles punctipennis* Say, *Anopheles maculipennis* Meig., *Anopheles franciscanus* McCr., *Psorophora ciliata* Fabr., *Ochlerotatus varipalpus* Coq., *Ochlerotatus lativittatus* Coq., *Ochlerotatus sylvestris* Theob., *Lepidoplatys squamiger* Coq., *Culex tarsalis* Coq., *Culex territans* Walk., *Culex pipiens* L., *Theobaldia annulatus* Schran., *Theobaldia incidens* Thom., and *Culiseta consobrina* Desv. At the present writing (1917) we have listed 27 species, viz.: *Anopheles punctipennis* Say, *Anopheles quadrimaculatus* Say (=*A. occidentalis* Dyar and Knab), *Anopheles pseudopunctipennis* Theob. (=*A. franciscanus* McCr.), *Aedes varipalpus* Coq. (=*Ochlerotatus varipalpus* Coq.), *Ædes onondagensis* Felt (=*Ochlerotatus lativittatus* Coq.=*Ædes quaylei* D. and K.=*Ædes curriei* Coq.), *Ædes taeniorhynchus* Wied. (=*A. damnosus* Dyar), *Ædes sylvestris* (Theob.), *Ædes squamiger* (Coq.) (=*Lepidoplatys squamiger* Coq.), *Ædes vittatus* Theob., *Ædes increpitus* Dyar, *Ædes palustris* Dyar, *Ædes cataphylla* Dyar, *Ædes ventrovittus* Dyar, *Ædes hexodontus* Dyar, *Ædes tahœnsis* Dyar, *Ædes sansoni* D. and K., *Ædes pallatus* Coq., *Culex tarsalis* Coq., *Culex territans* Walk, *Culex quinquefasciatus* Say (=*C. cubensis* Dyar=*C. fatigans* Wied.), *Culex stigmatosoma* Dyar, *Culex erythrothorax* Dyar, *Culex comitatus* D.

[1]Quayle, H. J., 1906 (*loc. cit.*)

and K., *Culiseta incidens* Thom. (=*Theobaldia incidens* Thom.), *Culiseta inornatus* Will. (=*Culiseta consobrina* Desv.), *Culiseta mackenæ* D. and K., *Uranotænia anhydor* Dyar (from larva only at San Diego by Dyar). Three other species are doubtful for California, *Psorophora ciliata* Fabr., *Ædes calopus* Meig and *Culex pipiens* L.

Malaria in California

The extent and prevalence of malaria in California is best described by Snow[1] viz.: "The United States mortality reports show that in 1909 California had one eleventh of all the deaths from malaria in the registration area, which includes eighteen states, and ranked second in number of deaths for a single state. Indiana was first with 125 deaths, New York third (95 deaths), Ohio fourth (75 deaths), Pennsylvania fifth (50 deaths). In proportion to population California outranks all other states in this area. Within the state 66 per cent of the deaths occurred in ten counties extending in an almost unbroken chain along the base of the Sierra Nevada Mountains. The total population for these counties (1910 census) is 326,896. Malaria, therefore, causes five times as many deaths per 100,000 of population as the average for the United States registration area. In these ten counties (Shasta, Tehama, Butte, Yuba, Placer, Sacramento, Amador, San Joaquin, Fresno, Kern) the 1909 death-rate from malaria was one death to 4,400 people. A second group of ten counties (Trinity, Sutter, Yolo, Napa, Contra Costa, Calaveras, Stanislaus, Merced, Tulare, and Kings) contiguous to those of the first group shows one death to each 15,820 of population. A third group of ten counties (San Francisco, San Mateo, Alameda, Santa Clara, Santa Cruz, San Benito, Monterey, San Luis Obispo, Santa Barbara, and Los Angeles) forming a chain along the coast shows one death to each 57,614 of population. Twenty-eight, or almost 50 per cent of the counties show no malarial deaths. Excluding the counties of San Francisco and Los Angeles, there remains the fact that two thirds of the population live in counties which contributed all the deaths from malaria, while one third of the population of the state live in counties which had no malarial deaths in 1909. A further study of the distribution of malaria in California shows Butte County 15 per cent, Sacramento County 10 per cent, San Joaquin 9.8 per cent, Fresno 6.2 per cent, Shasta 5.4 per cent of the deaths of 1909. Three counties, with only one sixteenth of the total population of the state, have more than one third of all the deaths from malaria.

"If the counties bordering the Sacramento and San Joaquin valleys

[1] Snow, William F. **Malaria.** California State Board of Health Monthly Bulletin, pp. 276-279 (Nov., 1910).

and sending tributary streams to these two great rivers be divided by a line from the Suisun Bay to Mokelumne Peak it will be found that eleven counties to the north of this line show 50 per cent of the deaths from malaria in 1909, and thirteen counties to the south of the line show 30 per cent of the deaths from this cause. In other words, the Sacramento and San Joaquin valleys contributed 80 per cent of all the deaths from malaria within these valleys. The following figures are significant: Nine of the twenty-four counties had 75 per cent of the deaths, or 60.6 per cent of the deaths for the entire state. These nine counties fall into three groups, (1) Placer, Sacramento, San Joaquin, with 25 per cent of the deaths and a population of 136,774; (2) Butte, Tehama, Shasta, with 24 per cent of deaths and a population of 57,622; (3) Fresno, Tulare, Kern, with 11.6 per cent of deaths and 148,812 population.

"Reducing these figures to terms of 100,000 population and comparing with the United States census average of 4.8 for the entire registration area, the Butte-Tehama-Shasta area shows 46.8 deaths per 100,000 population; the Placer-Sacramento-San Joaquin area shows 20.4 deaths per 100,000; and the Fresno-Tulare-Kern area shows 8.9 deaths per 100,000 population."

The above report on malaria conditions in California is not based on endemic indexes and has consequently been regarded by some as of comparatively little value. While the writer had not undertaken a systematic study of large numbers of blood smears, enough of these had been examined both prior to and after Snow's report that he is convinced that endemic indexes would have shown the statements above quoted practically correct. As it is, control work already accomplished would alter the situation.

Meyer[1] states "We examined the blood of 272 children in Gridley (Butte County) and of 364 children in Chico (Butte County) and found a tertian infection in each place (one seventeen-year-old Japanese boy in Gridley and one nine-year-old girl in Chico)." This could not well be regarded as a representative index, the work having been done early in the season (May 17–31, 1915) and included only a portion of the school children. A very much more significant index was made by Kelley[2] at Redding (Shasta County) where an index was made in October, 1915, based on 435 blood smears taken from as many school children showed thirty-five infected or an index of 8 per cent, there being 17 cases of aestivo-autumnal, 17 cases of tertian and

[1] Meyer, Karl F. The Malaria Problem. Trans. of the Commonwealth Club of California, vol. XI, No. 1, pp. 21–26 (March, 1916).

[2] Kelley, Frank K. Endemic Index of Malaria in the Northern Sacramento Valley. Journ. of the Amer. Med. Assoc. (In press).

one quartan. For comparison the endemic malaria indexes for several states after von Ezdorf[1] are here quoted, viz.: Alabama 11.4, Arkansas 10.1, North Carolina 7.8, South Carolina 11.9, Mississippi 31.2, Virginia 9.3. No doubt the endemic index for Redding (Cal.) would have been greater but for some mosquito control work which had been instituted during the previous two or three summers.

A Systematic Mosquito Survey

During the course of the seven years preceding the summer of 1916, the writer had gained some knowledge of the mosquitoes of California because of his extensive field observations, but as yet no systematic survey of the situation had been undertaken. Anopheline surveys such as were carried out by the United States Public Health Service in certain of the southern states under the direction of von Ezdorf[2] are fundamental to successful malaria control measures.

A notable advance was made during the summer of 1916 in our knowledge of the malaria-mosquito situation in California and consequently we believe decided progress has been made in the control of malaria in the state. On February 23, 1916, in the office of the president of the California State Board of Health, the writer in conference with the president and secretary of the State Board of Health and the director of the Bureau of Communicable Diseases presented the matter of a mosquito survey as the most urgent necessity in the program for the control of malaria in the state. An estimate was given as to the probable cost, items involved, etc. After some discussion the suggestion was favorably received and on March 4, the following resolution was adopted by the State Board of Health, namely, "that the State Board of Health undertake in coöperation with the University of California, a survey of malaria and mosquitoes in California under the direction of Professor W. B. Herms, assisted by Mr. S. B. Freeborn, provided the funds of the Board will permit of the financing of the plan." It was estimated that the expense of the survey would approximate $2,150 for the first summer including cost of automobile, maintenance, hotel expenses, and general equipment, there being no charge made to the State Board for the services of either the writer or Mr. Freeborn.

Without discussing in detail the equipment used in carrying on the survey, it may be said that this consisted of many maps, including

[1] von Ezdorf, R. H., 1916. Endemic Index of Malaria in the United States. United States Public Health Service, Reprint No. 331 from Public Health Reports of March 31, 1916.

[2] von Ezdorf, R. H. Anopheline Surveys. United States Public Health Service, Reprint No. 272 from Public Health Reports of April 30, 1915.

topographic maps, collecting outfit, numerous pill boxes and vials for use as insect containers, microscope, stain, cameras, first aid outfit, etc. The automobile used in the survey was of five-passenger capacity, equipped with a good sized dunnage box. The personal effects of the party were carried in cases and bags.

Between April 13, the date on which the automobile was received, and May 10, the day on which the scheduled survey began, a number of trips were made in the San Francisco Bay region as far south as Palo Alto to study certain local mosquito conditions. On the morning of May 10, the party, consisting of the writer, Mr. Freeborn and a student driver, who also gave his services free to the state, left the campus of the University of California. The first few days of the survey were spent chiefly in the Vaca Valley working from Suisun to Winters, thence to Dixon, Davis and Woodland, where a second party consisting of a group of University of California students joined in the work of the survey. This group of students remained with us for the first six weeks of the trip and proved of considerable value in collecting and locating breeding places. From Woodland our work proceeded up the west side of the Sacramento to Orland thence to Hamilton and south to Princeton and Colusa. From Colusa we again went northerly as far as Redding, thence southerly to the east side of the Sacramento to Chico, thence to Marysville. In each instance the intervening territory was carefully studied, and several days were devoted to a study of the more important communities and their tributary settlements. From Marysville we again proceeded northward to Redding, thence to Dunsmuir, Yreka, Hornbrook over the Siskiyou Mountains to Ashland (Oregon) in order to trace the species to the extreme northern boundary of the state. From Ashland the trip was made to Klamath Falls and at once into California again through Modoc County, stopping at Alturas, thence to Susanville and to Reno (Nevada) via Doyle. Our next headquarters were at Loyalton, thence to Sierraville, Truckee and Placerville via Lake Tahoe. Our first trip closed June 23, when a few days were spent at Berkeley to replenish our equipment.

The second trip began June 27, going directly to Sacramento thence to Marysville, Oroville, Quincy, Downieville, Nevada City, Grass Valley, Auburn, Truckee, Placerville, Jackson, Sonora, Yosemite, Merced, returning to Berkeley July 23. During this trip our principal object was to ascertain conditions in the northern Sierra foothill region.

On July 26 the third trip was begun and consisted of a survey of Marin County, particularly the salt marsh problem of San Rafael and vicinity, thence to Petaluma, Sonoma, Santa Rosa, Sebastopol, Healdsburg, Cloverdale, Hopland, Lakeport, Upper Lake, Middletown,

Calistoga and the Napa Valley, thence again to Berkeley. The final trip of the season consisted of a further study of conditions from Benecia to Suisun and the Vaca Valley, thence to Napa and Santa Rosa, northward to Ukiah, Laytonville, Eureka, Crescent City, easterly to Redding via Weaverville, southerly to Williams, westerly to Ukiah via Bartlett's Springs and Lakeport. From Ukiah the homeward journey was made via Santa Rosa and Napa including a mosquito survey of Mare Island. The summer's work closed August 14. From May 10 to August 14 we had covered 6,446 miles or 7,036 miles from April 13, and 31 northern counties had been officially included in the survey. We had travelled from sea level, actually on the sandy beach of the Pacific Ocean near Crescent City, to an elevation of about 8,000 feet in the Sierra Nevada Mountains. We had encountered rain, hail, snow, storm, heat and cold, often subjected to dangers and hardships, but we had visited the home of the mosquito and had seen at first hand conditions good and bad as they actually exist.[1]

Object and Method of Survey

The object of the survey was threefold, first, *scientific*, in that an accurate knowledge of the specific occurrence and distribution of mosquitoes and malaria was desired; second, *economic* and *remedial*, in that accurate information relative to the breeding places of the Anopheline species was needed in order that definite and practical suggestions for control could be offered; and third, *educational*, in so far as literature was distributed, lectures were given, conferences were held and much personal work was done among the ranchers. The objectives of the survey defined from the very start the methods pursued in our survey. The itinerary of each trip was prepared in advance and adhered to very closely. Adult mosquitoes were easily located in their hiding places during the day, commonly under bridges, in culverts and in outhouses. By the use of cyanide bottles made of shell vials (1″ to 1½″ deep and ¾″ in diameter) representative collections were made. After collecting them they were at once placed between cotton wadding in small pill boxes, each box given a number which corresponded to a number on a map. Breeding places were then located, descriptions were made and photographs taken in many instances. Ordinarily this peculiar performance attracted attention and soon one or more individuals were being told the object of our work. Health officers and other public officials were frequently taken into the field and given lessons in the recognition of mosquito larvæ, particularly the Anophelines, and were given suggestions for control. In nearly all communities resi-

[1]Herms, W. B. Progress Report on State-wide Mosquito Survey. Calif. State Board of Health Monthly Bulletin, vol. 12, No. 4, pp. 192–196. (Oct., 1916).

dent physicians were consulted relative to the occurrence of malaria in the vicinity and blood smears were examined wherever available. Public lectures, previously scheduled, were frequently given, usually illustrated with local material. Perhaps the most noteworthy lecture given during the summer was that at Redding before the state convention of County Supervisors. This was well attended and evidently well received. Hundreds of copies of the State Board of Health Special Bulletin No. 9 on "Malaria and Mosquito Control" by the writer were distributed. In most of the seriously infested localities a house-to-house distribution was made.

Results of Survey with Comments

We now have without doubt a very complete collection of the species of mosquitoes occurring in northern California and by the time the survey is finished a unique representative collection of these insects will be at hand such as few if any of the larger states possess. The specimens are being properly mounted and a card index of localities is being prepared so that information relative to the occurrence of mosquitoes in a given locality can be quickly and accurately ascertained. Our knowledge of the geographical distribution of the Anophelines has been greatly amplified. One or more of the specimens of Anopheles was encountered in all but one northern California county, and we were able to find numerous specimens of Anophelines, also located their breeding places, at an elevation of 5,482 feet (this at Sierraville).

We are even more impressed than ever that the Anopheles mosquito as a real menace to health does not wander far from its larval habitat, and that with the discovery of Anophelines their breeding place may be located within a very few rods of this point.

The chief source of Anophelines was quite commonly the green scum-covered edges of a small receding stream, creek or irrigation ditch, or grassy weed-grown pool of clear water. While the Anopheles mosquito may breed in vile stagnant water, it prefers clear, fairly cool water such as one frequently finds in smaller streams with sandy or pebbly bed. The current may be fairly swift in one part of the stream but the edges are commonly shallow and left-over scum-covered pools occur nearby.

While the survey has revealed the fact that Anopheline mosquitoes are more widely distributed than was at first believed to be the case and that consequently the malaria menace is also greater, we are no less positive in our belief that malaria can be brought under control. It is, however, a matter of detail, intensive rather than extensive. For example, a small overlooked pool of water, originating from a tiny stream beneath a fruit-packing house, may produce ample Ano-

pheles mosquitoes to distribute malaria among the employees who may work toward evening during the rush season, or larvæ may occur in an open spring which supplies drinking water for the nearby fruit-picking camp, etc. The successful operation of malaria campaigns calls for specially trained men.

Far too little attention is paid to the irrigation ditches and methods of irrigation in northern California. Until this matter receives proper attention there will always be more or less malaria in our irrigated districts. This is further evidence that details are overlooked and that the irrigation and drainage engineer to whom such matters as mosquito control are often referred is not meeting the requirements, that he is interested in the successful operation of the work at hand and is not responsible for the water as it may prove a menace to health. This is not ordinarily within the scope of his work. That there is little or no malaria in the irrigated districts of southern California is a mere coincident in the problem of conducting water from place to place in the most economical manner.

The recent introduction of rice culture in California brings with it new problems. These were studied with some care during the progress of the survey. Rice culture is evidently most successful in regions which also favor mosquitoes. In most instances both mosquitoes and malaria have preceded rice culture in a given locality, and the introduction of rice has merely increased the number of mosquitoes and the cases of malaria. In certain sections there is strong antipathy toward the rice industry because of its effect on health and comfort, on the other hand the rice grower displays a feeling of indignation because the entire responsibility is placed on his shoulders, in spite of the fact that both mosquitoes and malaria preceded the advent of his industry.

Out of our study of the rice situation there have come several important conclusions, namely that the rice grower is guilty of carelessness and does not practice sound agricultural methods. He is intent on quick returns at a minimum expense. The irrigation systems are as a rule carelessly constructed with the result that the roadsides are bordered for miles and in some instances actually covered by water. It is this careless and profligate use of water which is responsible for the enormous increase of mosquitoes. It seems quite reasonable to believe that more than 50 per cent of the trouble will be eliminated concomitant with the practice of scientific methods in the culture of rice.

Furthermore, after the water is drained from the fields in the autumn great numbers of pools remain along the contour checks and the roadsides in which mosquitoes continue to breed for some time after the

rice harvest, and again in the spring before the fields are flooded. Therefore it is recommended that mosquito control measures be put forth with vigor both before and after the fields are flooded.

While dragonflies breed in enormous numbers in the rice field they appear too late in the larval form to reduce the mosquito larvæ and the consequent hordes of mosquitoes to any appreciable extent. If dragonfly larvæ could be produced in sufficiently large numbers very early in spring and were transplanted to the rice fields at the beginning of the season some appreciable effect might be secured.

Bat roosts in the neighborhood of rice fields have been recommended but our experience with bats does not lend a very hopeful aspect to this means of control.

That much quinine is consumed in the malarial regions of California without apparent good results is quite evident. Self-treatment with large quantities of quinine without regard to schedule is commonly practiced. Enormous sums of money are expended for quinine and sundry patent medicines,—much of it uselessly.

The winter treatment of malaria carriers in all sections where the disease occurs and proper quinine prophylaxis in districts difficult to control deserve much more attention than is at present accorded these matters.

As a direct result of the malaria-mosquito survey there will come many new organized mosquito abatement districts under the act above described, but no doubt the greatest good coming out of the work is fundamentally educational in that literally thousands of persons,—men, women and children,—were reached on their own ground and were told what malaria is, how it is carried and how to control it. In many instances the writer saw the remedy (mosquito control) applied before he left.

It is planned to complete the survey of the state during the coming summer, starting early in May at the southern border and working northward.

The two papers were generally discussed by R. W. Doane, A. W. Morrill, Earl Morris, C. W. Woodworth, E. O. Essig and others.

CHAIRMAN A. W. MORRILL: The next subject will be presented by Mr. G. A. Coleman.

THE DEVELOPMENT OF THE MOTION PICTURE AND ITS PLACE IN EDUCATIONAL WORK

By GEO. A. COLEMAN, *University of California, Berkeley*

The story of the development of the motion picture camera and motion picture projectors reads like a fairy tale of romance, yet it is the story of real scientific achievement unequaled in its account of the overcoming of apparently insurmountable difficulties. For the solution of the scientific problems involved it has demanded the best talent from among European and American mechanical experts, designers and manufacturers of lenses, camera equipment, and chemists. The successful solution of these problems has only been possible through the coöperation of all.

Motion picture photography was born on the Stanford Ranch, Palo Alto, California, about 1872, when Governor Stanford was induced by Mr. Muybridge to allow him to experiment in photographing the governor's horses. The first motion pictures were made by setting up twenty-four cameras in a row facing the racetrack, each camera being equipped with an ingenious arrangement of a string and spring attached to the shutter. The horse in trotting past the cameras touched each string and so released the shutter, thus taking his own photographs, a series of snap shots. Governor Stanford rendered a real service to the science of Cinematography when he took these photographs to Paris and exhibited them, thereby gaining the attention and interest of Messioner, the great animal painter. Messioner was fascinated by them, because he was himself a great student of the curious attitudes which horses assume when in rapid motion, and had already attempted to incorporate in his paintings some of his own observations. These photographs gave him just the proof he needed to establish the correctness of his own observations with his fellow artists who were disposed to criticize his ideas and work. Indeed here we have the keynote to the use of the motion picture in scientific investigation and instruction, viz., an infallible record.

The motion picture camera has now been brought to a high state of mechanical perfection and optical efficiency. There are a number of good makes on the market. After a somewhat extended investigation of a number of foreign makes, the author has chosen the Universal camera and tripod, made in Chicago, which, equipped with a battery of lenses of from two to six inch focus, or longer if desired, makes an outfit adapted to all kinds of work afield, and will withstand the trying effects of all kinds of climate from the tropical jungle to the rigors of the arctic. (The outfit was here exhibited.)

The manufacture of motion picture films has kept pace with that of equipment, and owing to the indefatigable efforts of Mr. Eastman, we have film which will record anything the camera can take. To such perfection has the film, and the mechanical work of the camera been brought, that the taking of five hundred consecutive pictures in one tenth of a second, a thing undreamed of a few years ago, is now possible.

Here, then, we have the means of recording and reproducing for classroom and lecture room, and for careful study, all of the muscular and other movements of the vast animal and plant population of the entire globe. By means of the X-ray and the microscope, in connection with the motion picture camera, we can photograph not only the external, but the internal anatomy of every living thing upon the earth, in the air, or in the sea. When we stop to think of the vast field of investigation, of which we are just now at the threshold, we may stand in awe of the forces of nature, yet we cannot help but feel a profound respect for the powers of the human mind which has opened the door and let the general public get a glimpse of the innermost secrets which are so jealously guarded by old dame nature.

The "dry-as-dust" lecture on insect taxonomy can be enlivened now and then with a few feet of film, analyzing the "buzz" of the bee's wing, the "song of the katydid, or katydidn't," the "chir-r-p" of the cricket, the stride of "sir" beetle, and the sailing, or soaring, of "Madam Butterfly."

The insect biologist no longer needs to cover the walls with charts showing "all stages in life-history," etc., etc., or with curves, the key to which has long since been lost, for by means of the motion picture record he can get together a life-history stretching over months, or years, and present on the screen in a few minutes, the entire transformations for the eyes of the students, thus stimulating their interest to a study of the real insect life-history much more effectively than is possible with any series of dried or pickled specimens, however carefully they may be prepared.

Museum specimens have their uses, *as records*, but they also have *their limitations*, for classroom, or lecture demonstrations, besides, *it spoils the specimen*. Lantern slides were a step in advance, but too slow. The moment you introduce *motion* into your subject, your audience is fascinated, their attention riveted, and your point of instruction is driven home.

The economic entomologist need no longer fear the bugbear of classroom work, for he can now devote himself entirely to the research so dear to his heart, while an assistant merrily turns the crank of the Kinetiscope, or Pathescope, grinding out the pictures at the rate of

sixteen thousand every twenty minutes, stopping between reels to answer the stream of questions which the admiring multitudes of freshmen will certainly be stirred to ask. As for the general public,—a motor-driven machine, a few hundred thousand feet of film, covering all lines of scientific investigation, farm and orchard management, and you can take that long cherished—hut seldom realized hope—a real vacation.

The following paper was read by title:

SOME COMPARISONS OF COCCUS CITRICOLA AND C. HESPERIDUM[1]

By H. J. QUAYLE, *University of California, Citrus Experiment Station, Riverside, California*

Coccus citricola was described as a new species in 1914.[2] For some years previous to that time, this species of scale insect was confused with *C. hesperidum* as well as with one or two other species. The identity of the two species named is still a matter of doubt with persons not familiar with them, and, in certain stages or without ample material, their identity may not be plainly evident even to those who have given the species some study. Nevertheless the species in question are quite distinct, and it is the purpose of this paper to point out some of the differences and also some of the similarities.

The most important morphological characters separating these two species of scale insects are to be found in the antennæ, both as regards the number and the relative lengths of the joints.

Hesperidum almost invariably has seven joints, while *citricola*, in the great majority of cases, has eight joints.

In seventy-eight specimens of *citricola* in which 139 antennæ were examined, there were three scales each with seven joints in one antenna and eight in the other. In four scales there were seven joints in both antennæ, and in four others there were seven joints in one antenna while the other antenna was not examined. The remaining number, or sixty-seven, had eight joints in both antennæ.

In seventy-three specimens of *hesperidum* examined all had seven joints.

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[1]Paper No. 42, University of California, Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, California.

[2]Campbell, Roy E. A new species of Coccid infesting citrus trees in California. Entomological News 25: 222-224, 1914.

In all scales examined the seventh, or usually the next to the last, joint of *citricola* was shorter than the seventh, or last, joint of *hesperidum*.

With two exceptions the fourth joint of *citricola* was shorter than the fourth joint of *hesperidum*.

Considering averages, in the majority of antennæ examined the third joint of *citricola* was shorter than the third joint of *hesperidum*.

Considering averages, the fifth joint of *citricola* was longer than the fifth joint of *hesperidum*.

Although *citricola*, usually, has one more joint than *hesperidum*, the total length of the antennæ of *hesperidum* will average longer than that of *citricola*.

C. CITRICOLA

Average length, in micrometer spaces, of antennal joints:

1	2	3	4	5	6	7	8	Total
10.0	9.05	11.88	9.80	9.73	7.56	7.43	13.14	78.59

C. HESPERIDUM

Average length, in micrometer spaces, of antennal joints:

1	2	3	4	5	6	7	8	Total
10.2	9.94	15.92	16.82	6.60	7.18	16.43	—	83.09

In *hesperidum* the number of hairs of the anal ring is usually given as eight. In the original description of *citricola* six was the number stated for this species. Upon examination of the above characters, the writer finds that there are six large and two small hairs on the anal ring of both *hesperidum* and *citricola*. The two small hairs are not readily seen without dissecting out the part and mounting so as to show all the hairs in about the same plane. While, from the observations of the writer, the number of hairs of the anal ring is the same in both species in question, the difference in their length is very marked, those of *hesperidum* being about one-fourth longer than those of *citricola*.

There appears to be no well marked distinctions between the motile larvæ of the two species. The antennæ in this stage consist of six joints. In *citricola* there is an indication of eight joints by a more or less distinct separation of the fourth and fifth into two joints each. In the second instar there are still but six joints although the cleavage into two of the fourth and fifth joints is more pronounced than in the larva. In the third instar the adult condition of eight joints is acquired. In the case of *hesperidum*, the extra joint of the adult is probably formed by the fifth joint dividing into two.

In general appearance *citricola* may be distinguished by the more even distribution of the dark color pigment and the general ground

color of gray or dirty white. *Hesperidum* has the color pigment coalesced in more or less definite areas and the ground color is distinctly yellowish. In lustre, *citricola* is dull while *hesperidum* is shiny.

Hesperidum varies in shape more than *citricola*. The former may be straight on one side and curved on the other, or otherwise different from the usual oval, particularly, if they are situated along the midrib or if the specimens are crowded closely together.

It is in their life history and habits that the two species are markedly different. In *citricola* there is but one generation a year, while in *hesperidum* there are three or four over-lapping generations. Individuals of different sizes that may be seen at any one time in the case of *hesperidum* furnish a ready means of distinguishing the two species. From August to March all living specimens of *citricola* are uniformly of small size. During May, June and July there may be two sizes of this species, either mature individuals or very small specimens. *Citricola* is oviparous while *hesperidum* is ovoviviparous. The male of *citricola* is only occasionally seen. On citrus trees the puparium of the male of the black scale (*Saissetia oleæ*) is likely to be mistaken for that of *citricola*. The puparium of *citricola* may be distinguished from that of the black scale by the broader band, consisting of numerous cross lines, bordering the coronet. There are several references that refer to the male of *hesperidum*, but in the writer's judgment the proof in these references is not sufficient to say positively that the male described was of this species. Male puparia have been taken in the midst of infestations of *hesperidum*, but in all cases observed, they proved to be that of *S. oleæ*, *L. corni* or *C. citricola*, infestations of which were in the immediate vicinity. It is not unlikely that the male of *hesperidum* occurs, but evidence of the fact in the references at hand seems insufficient.

The host plants of *hesperidum* include a very wide range in number and variety. Those of *citricola*, as far as observed, include all varieties of citrus, hackberry, *Celtis occidentalis;* buckthorn, *Rhamnus crocea;* pomegranate, *Punica granatum;* night shade, *Solanum douglassi;* English walnut, *Juglans regiâ;* and Elm, *Ulmus americana*. The host plants named, other than citrus, were found infested in more or less close proximity to citrus. The discovery of the scale on hackberry, some of which trees were said to have been imported from Japan, led to the suspicion that the scale may have come from that country. But in correspondence with entomologists in Japan it is learned that *C. citricola* is not known to occur there, or at least is not native to the country. Mr. C. P. Clausen writes that he has seen what he considers to be *C. citricola* on citrus in Japan, and that it probably has been introduced from California.

C. citricola was first observed on buckthorn growing in the immediate vicinity of a citrus nursery. Since the buckthorn is a native plant, growing in the mountains and in waste places in the valleys, it was thought that the origin of the scale was accounted for. Upon further exploration of different areas where buckthorn grows, it was found that infestations of the scale on this plant did not occur at any great distance from infested citrus trees. The scale was found most abundantly on buckthorn growing in immediate proximity to citrus trees. It has been found in scattering numbers on the same plant growing in the washes from Claremont to Glendora. Specimens have been taken on buckthorn in the San Dimas and San Gabriel canyons two miles from citrus trees. It was not observed on buckthorn in the vicinity of Santa Barbara or in Laurel Canyon near Hollywood, or elsewhere. Further exploration of the buckthorn may result in a different conclusion, but at present it appears that *citricola* went from the citrus to the buckthorn instead of *vice versa*.

The parasites that have been reared from both *citricola* and *hesperidum* include *Coccophagus lecanii*, *C. lunulatus*, and *Aphycus luteolus*. *Microterys flavus* is a common parasite of *hesperidum* but thus far, there appears to be no record of this species being reared from *citricola*. *Coccophagus flavoscutellum* has been reared from *citricola* but not from *hesperidum*. Timberlake[1] records some other parasites and hyperparasites of *hesperidum* which have not been reared from *citricola*, but less extensive studies have been made on the parasites of the latter species. It is well known, however, that *citricola* is much less subject to attack by parasites than *hesperidum*.

At the South Carolina College and Station, two laboratories in charge of Mr. G. M. Anderson have recently been established in the southern part of the state; one deals with the boll weevil problem, and the other with the American mole cricket which is developing into a serious pest, especially of truck crops, at some points along the coast. Mr. J. A. Berly, research assistant, is in charge of the temperature-moisture problem at the home laboratory, working in coöperation with the division of Southern Field Crop Insects of the Bureau of Entomology. Professor W. A. Thomas has about completed his work on the cotton root louse and at present is engaged in a special study of the Aphididæ of South Carolina, with special reference to economic control. The work of the Crop Pest Commission has developed satisfactorily during the past year. An item of particular interest is the absolutely successful control of three heavy infestations of the cottony cushion scale in Charleston by the introduction of the Vedalia lady beetle, through the courtesy of the Plant Commissioner of Florida.

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[1]Timberlake, P. H. Preliminary report of the parasites of *Coccus hesperidum* in California, Jour. Econ. Ent. 6: 293–303, 1913; and Revision of the Genus *Aphycus*, Proc. N. S. N. M. 50: 561–640, 1916.

Scientific Notes

Aleyrodes citri not in Porto Rico. In the April number of *Phytopathology*, in an article on Porto Rican plant diseases, appears the following statement: "The fungus appears to be growing upon a scale insect, probably *Aleyrodes citri*." This statement refers to a white-fly found on the undersides of the leaves of Guava, the writer assuming that it is the notorious citrus white-fly.

Aleyrodes citri Riley and Howard has never been found in Porto Rico to our knowledge. There are, however, two species of white-fly that are commonly found on Guava in Porto Rico, *Aleurothrixus howardi* Quaintance and *Aleurodicus* (*Metaleurodicus*) *minimus* Quaintance, and it is very probably one of these to which the writer refers.

RICHARD T. COTTON.

How the Bureau of Entomology is Meeting the Great Issue. Immediately upon receipt of the news of the Declaration of War, the following letter was transmitted by the Chief of the Bureau to each member of the Bureau of Entomology, both in Washington and in the Field Service:

April 7, 1917.

"The crisis in which this country is placed makes it necessary for the Bureau to do all it can towards the conservation of our resources. It has been decided to establish a system of reporting local outbreaks of insects so that the Bureau will have the earliest possible information regarding unusual injury to crops. This service will receive reports on insect abundance, make tabulations and maps, and compile statements for the use of the men in the field as to probable damage.

"Will you please make it a part of your duty to report promptly through your section chief all observations on insect damage which are of more than usual intensity, and report the first occurrence of well-known pests. In all cases where possible numerical estimates should be made. This work should cover all injurious insects which may come to your attention regardless of the work in which you may be regularly engaged. It is not intended, however, that this shall supplant the regular work. It should be merely incidental but at the same time carried on to as full an extent as possible without interfering with other important matters.

L. O. HOWARD."

The Department of Entomology of the Alabama Experiment Station is endeavoring to do its bit in the campaign for increased food supplies partly through the saving of at least $2,000,000 worth of corn that is liable to be destroyed by insect attack in the cribs during the next two or three months. Furthermore, arrangements have been made for prompt reports by demonstration agents, agriculturists in our District Agricultural Schools and others of any threatening insect occurrence in this state. An effort will be made to get these reports much earlier than they would come ordinarily from the farmers themselves, so that remedial measures may be applied in time to prevent loss.

In the Gulf States section, the winter of 1916 and 1917 has been the most severe for perhaps 18 years past. Serious damage has been done by cold to citrus fruits and figs particularly, also in a less degree to other fruit crops. Probably as a partial result of winter injury, more numerous reports are being received of injury in which some new fungus diseases and borer injury seem to be associated. Some of these attacks are occurring upon a large variety of fruit and forest trees and promise to be serious problems for future study.

JOURNAL OF ECONOMIC ENTOMOLOGY

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The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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It may be well to call attention to practical limitations evident to anyone giving the matter thought and yet apparently ignored by some. Recent volumes of the JOURNAL have contained about 600 pages and represent practically all that can be issued with present resources. There are approximately 450 members with equal opportunities for publication. It was decided some years ago, and the policy seems on the whole a wise one, that precedence should be given to the Proceedings. That decision was made before we had a Pacific Slope Branch with its summer meeting and it seemed only an extention of the earlier policy to apply it to the western gathering. The large number of papers presented at a meeting necessitated limiting the time devoted to each and some have given abstracts or portions and submitted the entire paper for publication. Considerable discretion must lie with the Editor and the above statement is made for the benefit of one who becomes impatient at delay or who looks askance at suggested condensation. Some authors have withdrawn papers because they could not be published earlier and under present conditions the Editor was powerless, so far as hastening matters is concerned. Here is a place where we must all coöperate. Adaptation will do more to help the situation than rigid regulation.

Edwards' Bibliographic Catalogue of the Described Transformations of North American Lepidoptera is favorably known to economic entomologists and, in earlier days at least, was exceedingly useful. The

great expansion of knowledge since the above-named work appeared has made aids of this character most desirable. There is a manuscript which brings this publication nearly to date; it has been completed for some time and there appears to be no immediate prospect of its being published. The usefulness of this compilation, though technical in nature and necessarily somewhat extended, is apparent to every practical entomologist and it is suggested that those appreciating such assistance should interest themselves in this matter. The work would, in an indirect manner at least, be extremely helpful to an extended clientage, since the efficiency of the entomologist is greatly increased if he can have at hand a volume which will quickly and surely put him in touch with all available information concerning the Lepidoptera—a group comprising many of our most important and destructive pests.

Current Notes

Conducted by the Associate Editor

Mr. C. H. Calè has been appointed to take charge of the apicultural work at the Maryland State College of Agriculture at College Park, Md.

Mr. George G. Schweis, formerly assistant entomologist in the Nevada Agricultural Experiment Station, has been appointed etate apiary inspector for the etate of Nevada.

The following resignations from the Bureau of Entomology are announced: George H. Rea, to accept an appointment at Harrisburg, Pa.; Mr. Neuls, Alhambra, Calif., to go into business.

The legislature of Minnesota has passed a law authorizing the state entomologist to control the pine blister rust and appropriating $15,000 for the next two years for this purpose.

Mr. W. R. Walton of the Bureau of Entomology has been placed in charge of Cereal and Forage Insect Investigations, the position formerly held by the late Professor F. M. Webster.

Professor C. L. Metcalf of Ohio State University is to return about June 10 for the summer, to the Maine Agricultural Experiment Station for a continuation of his Syrphid studies.

According to *Science*, the Rev. O. Pickard-Cambridge, F. R. S., author of works on arachnology, entomology, and general natural history, died on March 9, at the age of eighty-eight years.

Mr. W. J. Chamberlin, assistant in Forest Entomology at the Oregon Experiment Station, has been granted an indefinite leave of absence to enter the Officers' Reserve Corps training camp in California.

Mr. Marion Wadley, a graduate student of the Kansas State Agricultural College, has accepted a position in the Division of Truck Crop and Stored Product Insect Investigations of the Bureau of Entomology.

Professor W. C. O'Kane, Durham, N. H., and Harold L. Bailey, Bradford, Vt., were among the entomologists attending the hearing regarding the white pine blister rust, held before the Federal Horticultural Board at Washington, D. C., April 10.

Mr. William C. Woods will be a member of the summer staff at the Maine Agricultural Experiment Station for the summer of 1917. He will be engaged with "Emergency Entomology" and special work with Chrysomelid beetles.

Mr. August Busck of the Bureau of Entomology recently visited Mexico, in the region of Monterey, San Pedro and Torreon, where Egyptian cotton has been planted, to study the extent of the pink bollworm infestation.

Mr. H. M. Parshley of the Bussey Institution, Harvard University, has accepted an appointment as assistant professor of Zoölogy at Smith College, Northampton, Mass., and will begin his duties with the next college year in September.

Mr. H. J. Reinhard, assistant entomologist of the Texas Station, is completing extensive studies on the artificial control of the cowpea weevil, *Bruchus quadrimaculatus* Fabr. Special attention has been given to heat as a means of control.

Professor Franklin Sherman, Jr., was appointed to represent the American Entomological Society at the inauguration of Wallace Carl Riddick as president of the North Carolina College of Agriculture, Raleigh, N. C., on February 22, 1917.

Professor Charles T. Brues of Bussey Institution, Forest Hills, Mass., Mr. Harold L. Bailey of Bradford, Vt., and Mr. James A. Hyslop of the Bureau of Entomology, stationed at Hagerstown, Md., recently visited the Connecticut Station at New Haven.

Dr. C. Gordon Hewitt, Dominion Entomologist of Canada, has also recently been appointed consulting zoölogist by the Canadian government, and will advise in matters relating to the protection of birds and mammals and the treatment of noxious species.

Mr. S. C. Clapp, assistant in Entomology, North Carolina State Department of Agriculture for nine years, has been appointed superintendent of the Mountain Station of the Experiment Station and State Department of Agriculture at Swannanoa, N. C., and entered on his new duties in February.

Very interesting but rather unexpected results are being obtained in the exhaustive artificial migration tests with the cotton or melon louse, *Aphis gossypii* Glov., by F. B. Paddock, state entomologist of Texas. There are two color forms of this species which complicates the migration tests.

At the annual meeting of the National Academy of Sciences convened April 16 and adjourned April 18, Mr. W. V. King, of the Bureau of Entomology, introduced by Dr. L. O. Howard, presented a paper entitled, "Sporogony of Malaria Parasites," with photomicrographs of infected *Anopheles*.

At the present time beekeeping is taught in the agricultural colleges in twenty-two states. In all but one or two cases this work has been inaugurated within the past five years. In ten of these colleges, the work occupies the exclusive attention of at least one instructor.

Mr. I. M. Hawley (Ph.D. Cornell) has been appointed assistant in the Division of Entomology, State Department of Agriculture, Raleigh, N. C., and began work in February. He succeeds Mr. S. C. Clapp. He will be responsible for much of the inspection work, and will also undertake some investigation projects.

Mr. C. H. Popenoe of the Bureau of Entomology has recently returned from a trip to Philadelphia for the purpose of inaugurating a fumigation of haled furs by the vacuum system. The John B. Stetson Company has recently installed a plant capable of a capacity of 50–1200 pound hales of fur per day.

Provision has been made to repeat the vacuum fumigation tests with pink bollworm larvæ under the direction of Mr. E. R. Sasscer of the Federal Horticultural Board to confirm results obtained in the earlier experiments, and also to determine the effect on these larvæ of the residual gas remaining in cotton hales. The living material for these tests was obtained from Hawaii through Mr. C. E. Pemberton.

Mr. E. J. Vosler, who for several years has been secretary of the California State Commission of Horticulture and editor of the *Monthly Bulletin*, has recently been appointed foreign collector of beneficial insects for the Commission. Mr. George P. Weldon succeeds him as editor of the *Bulletin*, and Mr. H. S. Maddox as secretary of the Commission.

The last General Assembly of Arkansas created a State Plant Board which will henceforth have charge of all orchard and nursery inspection work, and will have headquarters at Little Rock. Professor J. Lee Hewitt, plant pathologist of the Station, has recently been appointed chief inspector, and for the time being should be addressed at Fayetteville, Ark.

The following transfers have been made in the Bureau of Eotomology: E. J. Newcomer from Wenatchee, Wash., to Portland, Ore.; Alan G. Webb, Boston, Mass., to Seattle, Wash.; G. D. Smith, Thomasville, Ga., to Madison, Fla.; A. J. Ackerman, West Chester, Pa., to Benton Harbor, Mich.; Frank R. Cole, Washington, D. C., to Hood River, Ore.; C. E. Smith, Baton Rouge, La., to Muscatine, Iowa.

Dr. R. R. Parker, assistant entomologist of the Montana State Board of Entomology, will continue the study of the Rocky Mountain spotted fever tick this season and will be located in a field station at Musselshell, Montana. He will be assisted by Mr. R. W. Wells, who received the degree of Master of Science in Entomology from Montana State College this year.

Dr. G. F. White of the Bureau of Entomology, who has done much work on the bacteria of apiary diseases, has now been assigned to diseases of insects, Cereal and Forage Insect Investigations. He will give particular attention to bacterial diseases, such as wilts of larvæ, etc., and will be glad to receive specimens supposed to be attacked by bacterial or other diseases.

Mr. George H. Rea, who has been recently employed with the U. S. Bureau of Entomology, has been appointed Chief Apiary Adviser under the Pennsylvania Bureau of Economic Zoölogy, and will take immediate charge of the field work in this line. Approximately fifty demonstration meetings have been arranged for the month of May in various bee yards in thirty-three counties of the state.

Mr. C. H. Popenoe, entomological assistant, and Mr. N. F. Howard, expert on Insects as Carriers of Plant Diseases, both of the Bureau of Entomology, attended the meeting of entomologists and plant pathologists at Pittsburgh, Pa., April 16–17, to discuss plans for coöperation with the H. J. Heinz Company and state officials on the project of insects as carriers of cucurbit wilt and other diseases of truck crops.

The chief project taken up by Professor A. L. Lovett, entomologist at the Oregon Experiment Station, consists of a study of the toxic sprays for insects. The work this year will include an intensive study of spreaders for arsenate of lead, the use of calcium arsenate alone and in combination under Western Oregon conditions, and

the use of nicotine sprays and oil sprays as repellents for insects which disseminate fire blight.

Mr. W. H. Goodwin, who has been at the Ohio Experiment Station for nine and one-half years, entered upon his duties May 1 at the Pennsylvania Department of Agriculture, Bureau of Economic Zoölogy, and will be in immediate charge of the sixteen men in the field, known as "crop pest advisers." Especial emphasis is being placed this year on potato growing, with particular attention directed toward the control of pests ordinarily affecting this crop.

Dr. J. F. Illingworth, professor of Entomology, College of Hawaii, Honolulu, has been granted a leave of absence for three years, in order that he may carry on investigations for the Queensland government. He is to be located at Gordonvale, Cairns, North Queensland, in the midst of the sugar-growing section. An experiment station is to he developed, primarily for the study of the grub-pest, which is such a scourge in certain cane-growing areas.

The Connecticut legislature has recently passed a new crop pest law applying to future emergencies, and giving the director of the Agricultural Experiment Station authority to take such measures as may seem necessary for the extermination or control of all pests. A separate measure has also passed, appropriating $15,000 for the next two years for the control of the white pine blister rust; of this, $5,000 is at once available, and work has already been started.

The Iowa legislature has recently passed a law which reorganizes the apiary inspection work of the state and unites it with the extension work in beekeeping of the State College of Agriculture and Mechanic Arts at Ames, according to the recommendations of the present inspector, Mr. Frank C. Pellett. This change becomes operative July 1. It is understood that Mr. Pellett will relinquish the work on his own motion, but no announcement has been made regarding his successor.

Mr. H. L. Seamans, assistant state entomologist of Montana, will he occupied with crop defense work throughout Montana this season. In addition to answering emergency calls to suppress outbreaks of insect pests, he will tour the state and conduct a survey of important pests. For the most part travelling in the various counties will be done by automohile in company with the county agricultural agents. Several outbreaks of army cutworms have occurred already and young grasshoppers are abundant in some localities in western Montana.

Mr. J. L. King, who has been at the Ohio Experiment Station for five years, assumed new duties in the Pennsylvania Bureau of Economic Zoölogy beginning May 1, and he will devote his entire time and attention to a thorough biological study of the Angumois grain moth, which, in the five southeastern counties of Pennsylvania most seriously infested, caused damage to the extent of more than a million dollars in 1916. The hiology of this pest has not been thoroughly determined in this country, and the problem looks very interesting.

Mr. J. L. Webh, of the U. S. Department of Agriculture, Bureau of Entomology, has resumed work at Topaz, Calif., upon the Tabanids, *Tabanus punctifer* and *Tabanus phænops*. This projeet is undertaken in coöperation with the Nevada Agricultural Experiment Station. Studies will be made in Nevada and in adjacent portions of California. These studies will include general data on the injuriousness of the flies, their effect on growth and milk production, the relation between the abundance of the flies and irrigation and drainage, together with biological data and studies upon methods of control.

Mr. Hubert Jarvis, assistant entomologist of Queensland, made a flying trip to Hawaii during February. In spite of the brief time that Mr. Jarvis spent in the Islands he was very successful in his mission, which was the securing of a considerable stock of the lantana Agromyzid flies for his government. The signal success of these flies in Hawaii, in preventing the seeding of this most troublesome weed, had led other countries to seek similar relief. This Agromyzid, which apparently is an unnamed species, was introduced into the Hawaiian Islands by Mr. Albert Koebele many years ago.

The following entomologists recently visited the Bureau of Entomology at Washington: Dr. G. C. Crampton, assistant professor of Entomology, Massachusetts Agricultural College, Amherst, Mass.; Prof. J. Chester Bradley, systematic entomologist, Cornell University, Ithaca, N. Y.; Mr. R. C. Shannon, Cornell University, Ithaca, N. Y.; Prof. James G. Sanders, economic zoölogist, Harrisburg, Pa.; Prof. W. L. Chandler, instructor in Entomology and Parasitologist of Cornell University, Ithaca, N. Y.; Mr. J. R. de la Torre Bueno, hemipterist, New York, N. Y.; Prof. A. B. Cordley, director of the Experiment Station, Corvallis, Ore.; Dr. T. J. Headlee, state entomologist, New Brunswick, N. J.; Mr. J. R. Malloch, University of Illinois; and Mr. W. C. O'Kane, state entomologist, Durham, N. H.

In 1906, when Bureau of Entomology Bulletin No. 61 was issued, there were laws in twelve states providing for the inspection of apiaries. Most of these laws have been since replaced by more effective ones. At present there are such laws in twenty-nine states, and in addition, Hawaii and Porto Rico have regulations to prevent the introduction of bee diseases. In all there are about one hundred apiary inspectors in the United States. Thirty-four states now have state associations of beekeepers and five have associations for marketing honey. In addition to these there are now many county associations.

The following recent appointments are announced in the Bureau of Entomology: James A. Dew, Federal Horticultural Board, to be stationed at Eagle Pass, Tex.; Merton C. Lane, to be stationed at Forest Grove, Ore.; Herman J. Hart, assigned to the field station Wellington, Kan.; Dean A. Ricker, field laboratory, West Lafayette, Ind.; F. M. Wadley, Wichita, Kan.; H. K. Laramore, Plymouth, Ind.; Arthur J. King, Vashon, Wash.; O. A. Pratt, Calexico, Calif., transferred from the Bureau of Plant Industry. As collaborators in subtropical countries: Adolph Hempel, state entomologist of Sao Paulo, Brazil; Dr. Carlos E. Porter, director Institute Agricola de Chile, Santiago, Chile; F. W. Urich, government entomologist, Port of Spain, Trinidad; Archibald H. Ritchie, government entomologist, Jamaica; Patricio G. Cardin, government entomologist of Cuba, Santiago de las Vegas, Cuba.

The Connecticut mosquito drainage law has recently been amended by the General Assembly providing for a more comprehensive notice to property owners; for appeal and a method of assessing benefits and fixing damages; for state control of maintenance; that the law apply to work done before the passage of the present act if approved by the Director of the Agricultural Experiment Station; for the appointment of deputies; for one-fourth the cost of both maintenance and new work to be borne by the state, and the remaining three-fourths by the town, city or locality. The bill carries an appropriation of $10,000 to cover the state's portion, one-half for new work and the other half for maintenance.

The recent appropriations made by Congress for the Bureau of Entomology aggregate $931,480, being an increase of $62,600. For the control of the gipsy and brown-tail moths $305,050 is provided, and $25,000 is named for investigations relating to the cotton boll weevil, and lesser amounts are to be expended for special studies of

the Hessian fly, chestnut weevils, insects affecting pecans and other nuts, for the control of insect carriers of plant diseases in coöperation with the Bureau of Plant Industry, and for enlarging the work on insecticides. It is also contemplated that a field laboratory be established in the Ozark Mountain region in Arkansas and a field station in one of the New England States for investigations of the apple-tree tent caterpillar.

The Arizona legislature has appropriated $42,000 for the biennium beginning July, 1917, for the work of the state entomologist. Entomological work was organized in Arizona in 1909 with an appropriation of $3,000 supplemented by $600 from the Agricultural Experiment Station. Since then the successive legislatures have increased the appropriations from $3,000 a year to $5,000, $12,000, $14,000 and $21,000. The menace to the alfalfa crop by the introduction of the European alfalfa weevil into the adjoining state of Utah and the rapid development of the Egyptian cotton industry are factors largely responsible for the increasing interest shown in entomological work in the state of Arizona. After July 1, 1917, it is planned to add an assistant plant pathologist and a second assistant entomologist to the scientific staff.

Mr. Warren Knaus (class of 1882, Kansas State Agricultural College) has donated to the Entomological Museum of the Kansas State Agricultural College his valuable collection of Coleoptera. Ever since he was a student in the College, Mr. Knaus has spent practically all of his spare time and vacations in collecting and studying the Coleoptera. He has made many trips into the arid regions of Mexico, Arizona, Texas, and New Mexico to collect insects. These trips have been productive of a great many new species. His collection contains a number of species that are only found in one or two museums in the world, and these were furnished by Mr. Knaus. His collection will be kept as a separate one and will be known as the "Warren Knaus Collection."

An Insect Pest Survey and Information Service, has been undertaken by the State Entomologist of New York in coöperation with the New York State Food Supply Commission, the State College of Agriculture, the Farm Bureaus, the State Experiment Station and other agricultural agencies. It is also coöperating with the Emergency Entomological Service of the Federal Bureau of Entomology.

The main purpose is to secure prompt and accurate reports from all sections of the state, to summarize the information thus obtained, distribute it promptly and thus promote the checking or prevention in large measure of the enormous losses inflicted by insect pests. Particular emphasis is laid upon the initial signs of injury in order that damage may be anticipated and the insects controlled. The project is closely articulated with the control work in the field under the supervision of Messrs. Crosby and Matheson of Cornell University, and plans now maturing may result in what is practically an entomological patrol. The more important crops receive first attention, especially the insect enemies of potatoes, cereal and forage crops, truck and garden crops and the important fruits.

There are approximately one hundred observers reporting weekly and digests of the information with special recommendations in regard to the various pests are placed in the hands of the county representatives of the New York State Food Supply Commission and other interested parties with the expectation that every reasonable effort will be made to secure the general adoption of well-known and effective preventive or remedial measures.

Mailed June 19, 1917

solution of the problem. The writer made two trips to the valley and spent several days in company with Mr. Morris visiting the injured orchards, interviewing the owners and securing data upon which to base conclusions. Five samples of lead arsenate were secured from different orchards which had suffered from spray injury. The matter was gone over quite carefully with Mr. Morris; representatives of two important manufacturers of lead arsenate were interviewed; and the samples were examined by the writer. As a result of the investigation, certain conclusions have been made and will be submitted later on in the paper.

In order that the discussion of the case may be better understood, it seems well to present some theories of spray injury, to describe the commercial types of lead arsenate, and to point out the recognized susceptibility of stone fruits to spray injury.

Theory of Spray Injury

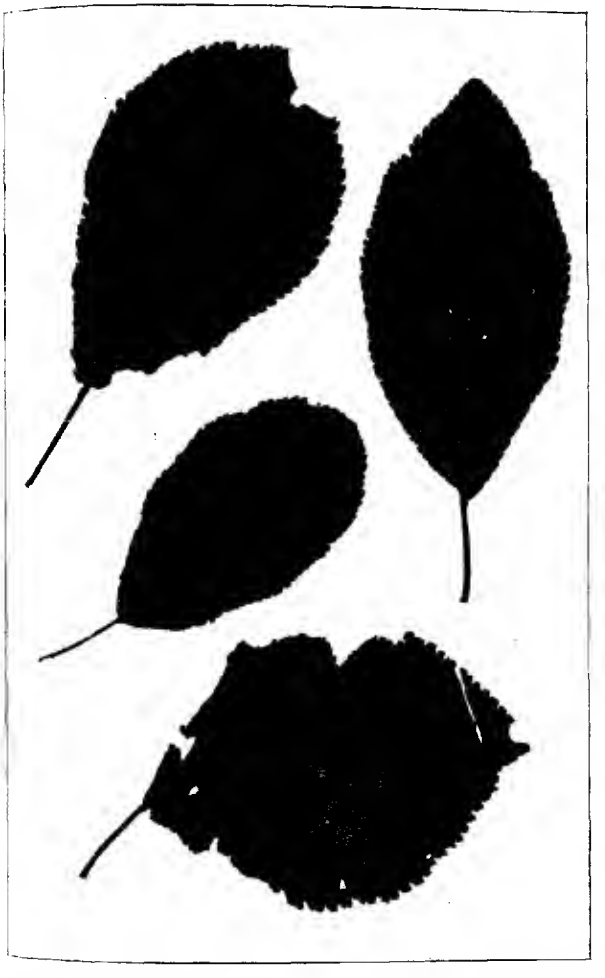
For injury to result from the application of a spray, it is necessary that the material be absorbed in some way. It seems quite essential that the material should be in solution before absorption can take place. At least, there is no evidence that a solid can enter the tissue of plants or animals to cause lesions of any sort. The modern practice of applying arsenicals to foliage is based upon the proper combination of the poison in a form which is insoluble in water in order to prevent its entering plant tissue and causing damage. It is generally recognized that the damage which is sometimes caused by arsenicals is due to the part of the arsenical which is soluble in water and which may thus enter the tissue of the plant to disturb its functions.

Arsenic has been combined with many substances to find a combination which is the least soluble and the least affected by weather conditions, and to find a combination that is the most suitable for use in other ways. Of all the combinations thus far tried, a chemical combination of arsenic with lead seems to most fully meet the above conditions. At present, there are two types of lead arsenate upon the market, each having its own place in spray practice.

Types of Commercial Lead Arsenate

Acid Lead Arsenate; Lead Hydrogen Arsenate (often Labeled "Standard".)—In an investigation to find the most suitable form in which an arsenical could be applied to foliage, Mr. F. C. Moulton,[1] chemist for the Massachusetts Gypsy Moth Commission, selected lead arsenate as the combination most suitable for use in this work. This arsenical offered so many advantages over other arsenicals in use

[1] Mass. Bd. Agr. Rept., 41, p. 282 (1894).



Prune leaves injured by the decomposition of acid lead arsenate during a succession of light misty rains. Taken from the orchard of Mr. F. J. Shepherd, Edenvale California, May, 1915. (Natural size.)

previous to his work, that it is rapidly supplanting all other forms of arsenicals for use on foliage. This arsenical may be prepared by mixing in proper proportions a soluble salt of lead, usually lead nitrate or lead acetate, and a soluble salt of arsenic acid, usually sodium arsenate. The process has been perfected and cheapened by commercial manufacturers so that the use of these soluble salts, as raw materials, has been largely discontinued. At present, many of the manufacturers prepare commercial lead arsenate paste from lead oxide (litharge) and arsenic acid. This process greatly cheapens and simplifies the manufacture of the paste in ways which need not be discussed in this paper. As ordinarily made, there results a compound which may be spoken of in chemical language as an acid lead arsenate or possibly a mixture of this and neutral or basic lead arsenate. It was found that lead arsenate produced in this way gave very uniform and satisfactory results in most cases for the control of leaf-eating insects.

Basic Lead Arsenate (usually Labeled "Tri-Plumbic" or "Neutral").—The lead arsenate produced in the usual way, however, was found to produce very serious foliage injury under certain climatic conditions which prevail in the Pajaro Valley, the principal apple growing section of California. In the spring of 1903, field and laboratory work was commenced by the Entomological Division of the University of California to find a more suitable arsenical or to modify the known methods of preparation of lead arsenate so that it could be used without injury under the conditions prevailing in the valley.[1] The field work was conducted by Mr. W. H. Volck and Mr. E. E. Luther, students in the College of Agriculture. After numerous experiments, the process of preparation was so modified that a new type of lead arsenate was produced which could be used with safety upon the apple trees in that section. The modified process and some theories of foliage injury are discussed in the publication previously referred to. This new process lead arsenate was at first believed to be what may be termed a neutral lead arsenate. Our knowledge of the chemistry of lead arsenates is still very imperfect, but later investigations seem to indicate that the material produced in the manner described by Volck[2] may more properly be referred to as basic lead arsenate.

Comparison of the Two Types.—To take up a full discussion of the composition of the two types mentioned would be of too technical a nature for presentation in a paper of this kind. The acid type is very susceptible to the action of other chemicals and is more or less

[1] Volck, W. H., Science, N. S., vol. XXXIII, No. 857, pp. 866–870 (1911).
[2] *Op. cit.*

dissolved by chemicals of an alkaline nature which are commonly found in many spray materials. This property distinguishes the acid type of lead arsenate from the basic. The latter is not easily affected by alkaline chemicals and is a much more stable chemical compound under neutral or alkaline conditions. It is not easily made soluble by ordinary influences. A theory was advanced by Volck that the acid type of lead arsenate was decomposed by the small amounts of ammonia (alkaline) which are sometimes present in the atmosphere, producing a soluble form of arsenic. Under the conditions prevailing in the Pajaro Valley, there was present on the foliage enough moisture to dissolve the soluble arsenic, thus formed, and make possible its absorption by the foliage. The basic lead arsenate, on the other hand, is absolutely insoluble in ammonia and soluble arsenic cannot be formed in this manner. Whether this theory is correct or not has not been fully confirmed by other experimenters, but the fact remains, however, that the basic type is the safer arsenical to use upon foliage in the humid coast regions. The basic type is practically the only arsenical which may be safely mixed with any of the other spray materials as a combination spray. This has been fully tested out in the Insecticide and Fungicide Laboratory and has been found to be much more suitable when alkalies of any sort are mixed with it. The acid type is a stronger poison, however, and its action upon the insects is much more rapid. The basic type contains much less arsenic to the pound and a much longer time is required to poison insects.

The stronger and quicker acting acid lead arsenate is therefore the one to be naturally selected for use upon foliage which is not peculiarly susceptible to spray injury and where the weather conditions are not apt to cause its decomposition, that is, in the more arid regions away from the coast. The basic type should be used whenever an arsenical is to be mixed with any other material (with one or two exceptions) as a combination spray. The *basic type* is the one to be recommended for use in the humid coast regions and upon *all stone fruits* or any others which are especially susceptible to spray injury.

Susceptibility of Stone Fruits to Spray Injury

It is a well-known fact that the foliage of all stone fruits is peculiarly susceptible to injury from many kinds of sprays. This fact has been noted in respect to the use of arsenicals and the California Agricultural Experiment Station has advised that the basic type of lead arsenate should be the only arsenical applied to stone fruits. The wisdom of this advice has been doubted by a great many and the cause of the doubt is not difficult to find. If the weather is favorable, the acid type of lead arsenate usually may be applied with impunity. In

fact, this has been done in the Santa Clara Valley for a number of years with only occasional bad effects. This year, however (1915), has shown that this procedure is not a safe one and some other way must be chosen if the growers do not wish to take the consequences of defoliation and fruit drop due to the effect of unfavorable weather conditions upon acid lead arsenate.

The weather conditions that are believed to favor the decomposition of acid lead arsenate are a succession of light rains extending over a period of several days, continual foggy or damp "muggy" weather, and more or less warmth. A heavy rain is not as serious as a mist, for if there is a decomposition of the arsenate, a rain sufficient to drip from the leaves may wash off the soluble arsenic before its absorption.

Weather Record for the Period of Spray Injury

The following weather record covering the period of spray injury has been kindly furnished by Mr. W. H. Ward of Morgan Hill, Cal., who was one of the orchardists to suffer quite seriously from spray injury.

The rain records are taken in the morning about 7 a. m. and are as follows:

April 20	.66 inch
April 26	.27 inch
April 27	.14 inch
April 28	.11 inch
April 29	.11 inch
May 1	.11 inch
May 3	.38 inch
May 4	.97 inch
May 9	.20 inch
May 10	.22 inch
May 11	.16 inch
May 13	.18 inch
May 16	.31 inch
May 23	.07 inch

The spraying was done on the Ward ranch on April 19 and on the afternoon of April 20. The weather was damp when the spraying was done the first day and it rained the night following. The spraying was finished the next afternoon.

The amount of acid lead arsenate used was from 4 to 4¼ lbs. to 100 gallons of water. This was about the amount used by the other growers. The injury was noticed about two weeks after the application of the spray.

Theories Confirmed by the Investigation

As previously noted, five samples of lead arsenate paste were collected during the progress of the investigation. These samples were

taken from parts of kegs of the paste which were said to have been left over from the previous sprayings which had caused the injury. The labels were in some cases obscure, but from the information gathered from the labels, from statements by the growers and by the dealer supplying the arsenicals, it seems that the five samples represented at least three different brands of lead arsenate. Examination revealed the fact that they were all of the acid type. None of them contained an unusual or dangerous amount of soluble arsenic. In fact, one of the samples showed only a trace of soluble arsenic. The samples were in all respects normal as far as could be determined. Furthermore, the samples representing three different brands, it *seems improbable that all three of the companies should happen to produce a poor grade of material at the same time.*

The orchard of Mr. August Nielson in the Evergreen district near San José was visited, which consisted principally of apricots. There were, however, three rows of apple trees running across this orchard. The whole orchard was sprayed with acid lead arsenate on April 13. Five pounds of lead arsenate were used to the 100 gallons. Foliage injury and dropping of leaves and fruit was noticed before the first of May following. The whole orchard was uniformly sprayed with the strength of arsenical given above. It was noticed that spray injury occurred on the foliage of all of the apricot trees while no injury could be detected upon the foliage of the apple trees. The point brought out by the above observation is that the stone fruits only were injured, that the apple trees were uninjured, and that the lead arsenate used could not be considered of poor grade.

The adjacent orchard of Mr. R. Chaboya was also visited. This orchard consisted almost entirely of prune trees. Only a part of the trees in this orchard were sprayed, some of which were sprayed twice and some once. It was observed that the most defoliation resulted where two sprayings had been made. Wherever the trees had been sprayed, foliage injury was apparent. No foliage injury was observed upon the trees which had not been sprayed. This observation, as well as similar observations on other orchards, leaves no room for doubt that the injury had been caused by the spray.

Observations were also made on a prune orchard owned by Mr. F. J. Shepherd, Edenvale. Only a part of the trees had been sprayed. Those sprayed uniformly showed injury, while those not sprayed showed no injury. This observation confirmed the above. Many other orchards were visited. To record the observations made would largely be a repetition of the above. It was noticed, however, in this connection that occasionally a pear or an apple tree had been sprayed with the arsenical and in no instance could injury be detected, while

in every case where stone fruits had been sprayed, with acid lead arsenate, more or less injury was apparent.

Summary

According to the observations made of stone fruits to which acid lead arsenate had been applied during the month of April, 1915, they showed injury to a greater or less extent. Pome fruits which were sprayed under the same conditions causing the injury as above noted showed no injury. Examination of five samples of lead arsenate collected during the investigation represented three different brands. In no case did the analysis reveal the presence of unusual quantities of water-soluble arsenic. The samples were all good grades of acid lead arsenate. According to weather records and to the testimonies of the growers, a period of damp, misty weather prevailed during and after the application of the lead arsenate causing the spray injury. It seems reasonable to conclude:

1. The acid type of lead arsenate, often labeled "standard," is unsafe to use on the foliage of stone fruits except under favorable weather conditions.

2. According to weather reports, it appears that during the spring of this year (1915) (particularly during the month of April) unusually unfavorable weather conditions prevailed in the Santa Clara Valley, Cal.

3. The foliage injury in the orchards of the Santa Clara Valley this spring was due to the decomposition of acid lead arsenate by the weather.

4. According to previous experience and in accordance with previous recommendations of the University, the basic type of lead arsenate (usually labeled "tri-plumbic" or "neutral") is a safer arsenical to use on stone fruits and is not decomposed by unfavorable weather conditions. This is a slower acting poison, however, than the acid type and would not be as effective unless applied when the canker worms are very young.

Recommendations

In looking up the recommendations of entomologists and taking into consideration the experiences previously noted, it appears that there is a choice of three procedures for the control of canker worms:

1. Banding of trees has been found to give satisfactory results. Essig[1] may be cited as authority for recommending "tree tanglefoot" for the control of both spring and fall canker worms.

2. The acid type of lead arsenate may be successfully used on stone

[1] Essig, E. O., Injurious and Beneficial Insects of California, pp. 417 and 415.

fruits for the control of canker worms *provided the weather conditions are favorable.* It is *not recommended,* however, for general practice as there can be no guarantee of what the weather may be after the application of the arsenical.

3. It is *very strongly recommended,* when necessary to use an arsenical upon stone fruits, that the *basic type of lead arsenate be used exclusively.* In order that this slower acting poison may be effective, it will be necessary to keep a close watch of the orchards and make the application while the worms are very young.

WILD VEGETATION AS A SOURCE OF CURLY-TOP INFECTION OF SUGAR BEETS[1]

By P. A. Boncquet, *Bacteriologist, Collaborator,*[2] and C. F. Stahl, *Scientific Assistant, Truck Crop and Stored Product Insect Investigations, Bureau of Entomology*

The curly-top condition of sugar beets has for some time been a subject of investigation by phytopathologists, but on account of the failure to discover a specific organism responsible for the physiological injury to the plant, the problem has been peculiarly baffling. Although the connection of the jassid leafhopper, *Eutettix tenella* Baker, with the disturbance has been definitely established, conclusive evidence has not previously been available as to the exact nature of the trouble, or as to the part played by the leafhopper in the dissemination of the virus. It is believed that the results secured as herein related may be of assistance in establishing in part the nature of the disorder, the identity of its probable alternate hosts and the conditions governing its somewhat periodical or sporadic appearance in beet fields.

A brief review of the investigations leading to the experiments which will be mentioned may serve to emphasize the significance of the results obtained.

The connection of *Eutettix tenella,* known both as the sugar-beet leafhopper and the curly-top leafhopper, with the condition was first definitely established in 1909.[3] Soon afterwards it was found that a single leafhopper in any stage was capable of producing the condition

[1] Published by permission of the Honorable Secretary of Agriculture.

[2] Since this article was first presented for publication, Doctor Boncquet has been absent in Argentina. He has not, therefore, had the opportunity of approving some of the corrections in the manuscript.

[3] Ball, E. D. The Leafhoppers of the Sugar Beet and Their Relation to the "Curly-leaf" Condition. U. S. Dept. Agr. Bur. Ent. Bul. 66, pt. 4, p. 33–52, pl. 1–4, 1909.

by feeding on a healthy beet for two minutes.[1] In these experiments it was further demonstrated that insects reared from the egg stage on healthy beets were unable to produce the characteristic condition

The curly-top leafhopper feeds on a number of species of wild plants, in addition to its attacks on the sugar beet. Specimens collected from wild host plants were accordingly tested on healthy beets, but without bringing about the curly-top condition.[2] They acquired the ability to cause the characteristic symptoms of the condition by feeding on affected beets. This ability was lost in from 15 to 35 days if the insects were transferred daily to healthy beets. A period of incubation, dependent on temperature, and lasting at least two days was required.[3]

The apparently sporadic occurrence of curly-top outbreaks in remote isolated desert regions, where beets had never before been grown suggested either that the leafhopper was capable of migrating to great distances, or that the virulent factor resided in other food plants than the beet, and was perpetuated either in a virulent form or in a symbiotic relation by these plants. The first being untenable, the second suggestion was investigated, the results obtained to the present time apparently justifying this paper.

Recent Investigations

Early in the fall of 1915 it was observed that many mallow plants (*Malva rotundifolia*) (Pl. 17, fig. 1) growing in the vicinity of beets affected with curly-top showed signs of abnormal development (Pl. 18, fig. 1). The plants were dwarfed and the leaves were irregularly contorted, the growing bud stunted, showing only two or three extremely small leaves, indicating a widespread disturbance in growth. Several of these abnormal plants were examined microscopically, revealing internal lesions similar to those observed in beets affected with curly-top. The phloem was injured not only in the stem and roots but even in the extreme parts of the leaves. The medullary rays of the stem were also attacked and in some places showed total disintegration.

[1] Smith, R. E., and Boncquet, P. A. New Light on Curly-top of the Sugar Beet. *In* Phytopathology, vol. 5, p. 103, 1915. Connection of a Bacterial Organism with Curly-leaf of the Sugar Beet. *In* Phytopathology, vol. 5, p. 335, 1915.

[2] Boncquet, P. A. *Bacillus morulans*, n. sp. Thesis presented for degree of Doctor of Philosophy at the University of California. University Documents, 1915. The Comparative Effect upon Sugar Beets of *Eutettix tenella* Baker from Wild. Plants and from Curly-leaf Beets (with W. J. Hartung). *In* Phytopathology, vol. 5, p. 348, 1915.

[3] Smith, R. E., and Boncquet, P. A. New Light on Curly-top of the Sugar Beet. *In* Phytopathology, vol. 5, p. 103, 1915. Connection of a Bacterial Organism with Curly-leaf of the Sugar Beet. *In* Phytopathology, vol. 5, p. 335, 1915.

Special staining methods demonstrated that organisms[1] similar to those previously found in affected beets were present. This striking resemblance suggested the possibility of the mallow being an alternate host in beet infection, and experiments were started to determine the relationship. In order to verify these assumptions two different methods were devised which, if successful, would furnish unquestionable proof. These methods were only the consequence of previous results obtained during investigations relating to virulent and non-virulent insects.

Experiments

In the first set of experiments two factors were most essential for success: (1) Insects must be used which were known to be non-virulent; and (2) beet plants must be used which had been grown under cover and were known to be healthy. Mallow plants (*Malva rotundifolia*) which showed signs of some disturbance (Pl. 18, fig. 1) were selected, growing in the field which contained a large number of beets affected with the characteristic curly-top. A microscopic examination disclosed internal disorders similar to those previously mentioned. Insects which had been kept under close observation for more than six months and which were known to be non-virulent were selected and placed on the mallow in small leaf cages. After several days these insects were removed and placed on healthy beet plants in specially constructed cages. These beet plants were kept under close observation and the first symptoms of curly-top noted (Pl. 18, fig. 2). One insect was placed on an affected beet instead of a mallow plant and was used as a check so that it could be ascertained whether or not the condition would develop normally during the fall season of the year. Table I shows the results of these experiments.

Table 1.—Experiments in the Placing of Non-Virulent Specimens of Eutettix tenella on Affected Mallow Plants and Their Subsequent Transference to Healthy Beet Plants, Resulting in Curly-top Infection

Exp. No.	Date Placed on Mallow	Date Transferred to Healthy Beet	Date of First Symptoms of Curly-top	No. of Insects Used
1	Oct. 22, 1915	Oct. 27, 1915	Dec. 17, 1915	1
2	Oct. 27, 1915	Nov. 5, 1915	Jan. 10, 1916	1
3	Oct. 27, 1915	Nov. 5, 1915	Remained healthy	1
4	Oct. 27, 1915	Nov. 5, 1915	Nov. 29, 1915	1
5	Oct. 27, 1915	Nov. 5, 1915	Dec. 22, 1915	1
(Check on affected beet plant)				

[1] Boncquet, P. A. *Bacillus morulans* n. sp. Thesis presented for degree of Doctor of Philosophy at the University of California. University Documents, 1915. The Comparative Effect upon Sugar Beets of *Eutettix tenella* Baker from Wild Plants and From Curly-leaf Beets (with W. J. Hartung). *In* Phytopathology, vol. 5, p. 348, 1915.

After remaining on the healthy beets for about two weeks all insects employed in the foregoing experiment were transferred to other healthy beets and the results were duplicated. Actual dates were not recorded, but all cases developed somewhat more rapidly than usual, due to the fact that the plants were kept in the greenhouse where the temperature was much higher. It will be noted from these results that the time required for the symptoms to develop was quite long, in fact much longer than was the case during the preceding summer in experiments with other phases of the condition. This unusual length of time was due to the unfavorable weather conditions prevailing later. The days were cold and cloudy and growth of the beets was practically at a standstill. It has been observed in these and other experiments that the symptoms of the condition do not appear unless the plant is growing. Two causes may be responsible for the fact that No. 3 did not show curly-top symptoms. Either the mallow was not affected, or the weather and the conditions in the beet plant were such that the organism was killed before it had a chance to develop. This assumption was more strikingly borne out in the following results, obtained from similar experiments at a later date. December 1, 1915, one of the same mallow plants was selected and six non-virulent insects placed upon it in a lantern globe. After a period of seven days they were removed and placed singly on healthy beets. None of these transfers brought about the disorder, all beets remaining healthy. As this mallow plant had been proven to be infected in the past experiment there is no doubt that unfavorable conditions were responsible for the negative results obtained. There may perhaps be a latent period in the life cycle of the causative agent while in the plant, or the agent may have been unable to withstand the unfavorable temperature.

The actual production of the condition in a healthy mallow plant by a virulent insect, and its subsequent transfer from the mallow to a healthy beet by a non-virulent insect, is the crucial point in the experiment. Small seedling plants for this test were grown in insect-proof cages and used as soon as they were large enough to be easily handled. First, six insects known to be virulent were placed on each mallow plant and were allowed to remain for a considerable period, after which they were removed. Non-virulent insects were then placed on the same plant and allowed to remain at least one week, when they were removed and placed on healthy beets. This experiment was conducted in a room in the laboratory where conditions were more favorable for the development of the condition. The results obtained are given in Table II.

TABLE II.—EXPERIMENT IN THE INFECTION OF HEALTHY MALLOW PLANTS BY VIRULENT SPECIMENS OF EUTETTIX TENELLA AND THE TRANSFERENCE OF THE CURLY-TOP INFECTION TO HEALTHY BEETS THROUGH THE AGENCY OF NON-VIRULENT SPECIMENS OF THE INSECT

Exp. No.	Virulent Insects Placed on Mallow	Date Removed and Non-Virulent Insects Placed on Mallow	Date Placed on Healthy Beets	Date when first Symptoms of Curly-top Appeared	No. of Insects Used
1	Nov. 10, 1915	Nov. 30, 1915	Dec. 14, 1915	Jan. 20, 1916	6
2	Nov. 10, 1915	Nov. 30, 1915	Dec. 14, 1915	Feb. 15, 1916	6
3	Dec. 1, 1915	Dec. 15, 1915	Dec. 27, 1915	Mar. 10, 1916	6
4	Dec. 1, 1915	Dec. 15, 1915	Dec. 27, 1915	Mar. 29, 1916	6

CONCLUSION

The foregoing experiments show the possibility that common weeds may assist in the perpetuation of the infectious factor which causes the curly-top of sugar beets. That these findings are of the greatest significance can be easily understood. Indeed they introduce a definite field of investigation for the control of this most destructive condition. One fact stands out most prominently from all evidence gathered up to the present time, namely, that the insects must be infected in order to be able to cause the disturbance. From their nature these insects in themselves are unable to produce the disorder. Hence, affected plants are required for reinfection of the insects before a general outbreak can be started. There must be present either some beets affected with curly-top in the fields or weeds which harbor the virulent factor, even in a symbiotic way. Clean cultivation, already extremely desirable from the standpoint of diseases and insect pests, especially during the period that no beets are in the field, is thus necessarily indicated as a means of prevention. Even though all vestiges of affected beets from the previous year have disappeared, and all volunteer beets have been eliminated, there remains the possibility that certain weeds, such as mallow, may harbor the virulent factor during hibernation. After clean cultivation has been put into practice attention must be directed to the surrounding native vegetation. The discovery of the original host plant among this vegetation is the next problem to be considered, and investigations are in progress to determine this point.

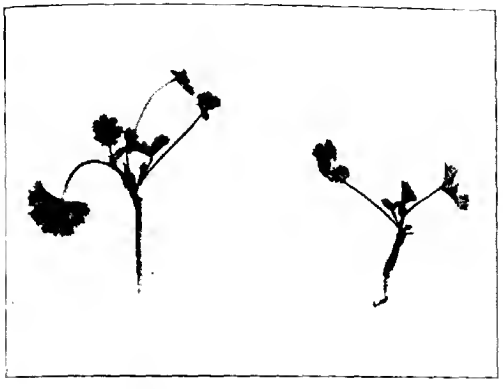
SUMMARY

Malva rotundifolia, a common weed in the beet fields, has proved to be at least a symbiotic host of the virulent factor of curly-top of sugar beets.

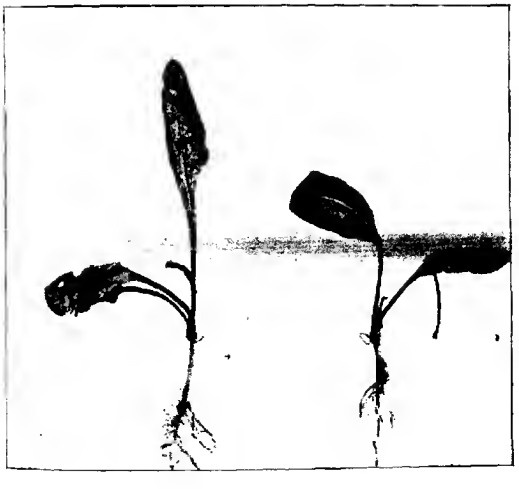
Individual insects of the curly-top leafhopper (*Eutettix tenella* Baker) known to be non-virulent were placed on sickly-looking mallow

2

1, Healthy plant of mallow (*Malva rotundifolia*). (Original.) 2, Sugar beet showing typical curly-top infection. (Original.)



1



2

1, Mallow plant (*Malva rotundifolia*) harboring virulent factor causing curly-top of sugar beets. (Original.)

2, Beet plants showing effect of curly-top infection transferred from mallow plants. (Original.)

plants in the field. They were subsequently placed on healthy beets grown from seed in insect-proof cages. The condition was produced in four experiments.

Insects known to be virulent were placed on healthy seedlings of *Malva rotundifolia*. After a certain lapse of time they were removed and replaced with non-virulent insects which were later transferred to healthy beets. All transfers brought about the disorder.

These discoveries throw considerable light on the nature of the condition of sugar beets called curly-top, and establish beyond doubt the possibility of preventing or limiting injury by this condition through the control of the leafhoppers affecting the beets, and through the establishment of clean cultural methods, by means of which infected plants which act as hosts to the leafhoppers may be removed from the vicinity of beet fields.

RELATION OF THE COMMON ROOT MAGGOT (PEGOMYIA FUSCICEPS ZETT.) TO CERTAIN CROPS IN LOUISIANA

By E. S. Tucker, *State Agricultural Experiment Station, Baton Rouge, La.*

Attacks on Young Tomato Plants

A number of injured tomato plants ranging from five to six inches in length and a few specimens of a small maggot said to have been found burrowing in the stems of similar growth were brought to the writer for examination on March 3, 1914, by a merchant of Norwood, East Feliciana parish, La. He stated that a gardener of his home town had lost more than 1,000 plants like the samples, from stock grown under culture in a coldframe, all having failed in the short time of about two days. When the bed was covered on Saturday evening, February 28, the growth appeared to be perfectly healthy; but on opening the frames on Monday, March 2, the owner noticed many drooping plants, and by close examination, determined the cause of damage through discovery of some maggots in the stems. Other growers also complained that their beds were likewise being depleted.

The sudden loss of great numbers of plants in such manner naturally excited some alarm among the growers, who feared that the trouble might become more extended and thus restrict their production of a tomato crop for the approaching season. Since none of the gardeners had ever before known an enemy of this kind to do any harm to tomato plants, the question of its identity and life-history, and how to deal with it, presented an entirely new problem. For the benefit of the community, therefore, the merchant hastened on a visit to consult

an entomologist for the purpose of obtaining information about the pest and means of checking its ravages.

Careful examination of the injured plants submitted by him revealed two distinctive effects of attacks, denoting both external and mining tendencies of feeding by the enemy. As the stem was the only part showing violence, the plants had consequently received wounds in a very vital place. Even cuts of slight size appeared to have eventually produced nearly as fatal results as had been caused by extreme inflictions. Ample evidence of the primary and of course the more prevalent mode of attack was exhibited by the presence of scars. They also commonly demarcated the secondary damage that was disclosed by a tiny opening leading into the interior of the stem. These scars varied from a mere scraping to a rough cavity in the tissues, all being made conspicious by their black discoloration. They were located at different heights on the stem, ranging from near the roots to a distance of an inch or more above, but evidently depending on the depth of insertion in the soil.

In most instances, a plant had suffered but a single infliction. Burrowed stems, however, had usually become too weak to support the upper part of the plant, yet the fallen top remained attached at the infirm place by the shreds of withered tissues. The longest burrow found in any stem measured fully an inch. Every boring extended upward from a scar where a maggot had manifestly worked its way into the heart and there pursued its ravages. Although no additional maggots could be detected, the injuries were typical of operations by such creatures. The specimens at hand agreed very closely with a figure of the corn seed maggot. But positive identification of the species involved the necessity of securing adult examples or the actual fly.

While no occurrence of exactly the same nature had ever before come to the attention of the writer, yet reference to publications treating of maggots known to attack roots and stems of vegetables afforded a choice of several methods of protection against such foes, as recommended by authorities on the subject. Among the methods given, selection was made of two whose applications would seem to be most feasible under the circumstances, and a trial of each was accordingly proposed. One of the treatments required the use of oily sand, which should be prepared by mixing a cupful of kerosene in each pail of dry sand as would be needed, this to be placed close around the plants remaining in the beds. The other recourse depended on a liberal scattering of tobacco powder, which substance is claimed to serve as a fertilizer in addition to its repellent property against the maggots.

In order to render assistance based on practical experience in dealing

with this sort of enemy under Louisiana conditions, a visit for investigation was deemed expedient to acquire an understanding of the habits of the depredators with relation to the cultural practices of the truck growers, and to learn whether more than one kind of pest were involved or not, and also to determine the results of steps taken for preventing further harm by such foes. With this object in view, the writer proceeded to Norwood on March 6. For courtesies received, his thanks are especially extended to the merchant, who, in generous service to the growers, not only furnished accommodations, but gave his time, for facilitating observations.

Through a survey of the situation, not much difference was found to exist in cultural management, although some beds showed more careful preparation than others and had produced a superior growth of plants. As a general practice, the bedded soil had been heavily enriched with a commercial fertilizer said to have contained a quantity of cotton seed meal. Only one grower stated that he had used stable manure, yet his plants were beginning to fail. All the beds had been prepared solely for the forcing of tomato plants, being protected by the construction of a coldframe enclosing each one. While the entire stocks of these coldframes had been transplanted from seed beds, yet none of the growth left in the original places on account of its inferior size was said to be molested by maggots.

Since the owners of the depleted frames had made good progress in replanting them, leaving the surviving plants of the first lot as they already stood, but filling in with a fresh supply taken from seed beds, the great loss of stock so far sustained was therefore only partially shown. Enough evidence was seen and learned, nevertheless, to prove that the extent of damage together with imminent danger of further ravages had brought the growers to face a grave predicament. The replacements of plants necessarily consisted of smaller growth than was desired, and unless these settings could be saved, the reserve stocks in seed beds might be insufficient to depend on for growing as much of a crop as was planned, besides being apt to mature late. A shortage of the advanced growth would handicap the producer, at least by limiting the yield of fruit in time for market early in the season when high prices rule.

In all the instances where depredations had been committed, nothing else than maggots could be held accountable for the principal destructive work. Very seldom was any indication of cutworm damage or sign of disease apparent.

One gardener, whose stock was inspected, claimed that he had lost about 3,000 plants of a size like the living growth of the same lot left in his coldframe. These remaining plants averaged 8 inches in

height measuring from the base of the stem. The spaces made vacant by the losses had just been reset with slightly smaller stock. Yet scarcely any of the plants kept from the first setting were found to be in a sound state. Most of them looked healthy as they stood, showing no injury above ground, when in fact, nearly every stem proved to be blemished by one or more wounds, all of which had been originally inflicted only on the part buried in the soil.

Deterioration by withering and decay following upon the wounds had in many cases reduced the tissues to shrunken and blackened shreds which broke apart on the slight strain of a pull exerted by efforts to lift the plants. Such defects commonly marked the starting point of a boring that penetrated upward through the soft heart, and these bored stems occasionally contained a maggot. During the day before, the owner took a number of withered plants and showed them to the merchant, who on opening the cavities, exposed as many as seven maggots infesting a single stem.

The heart of some stems had been excavated up to the juncture of the lower branches, and in one instance, a burrow extended onward for a short distance into a thick branch itself. Among the plants examined here, one happened to attract particular notice on account of a bunch of new rootlets which had grown out from the base of the stem just above a breach, the lower portion with the original root system having become withered and practically dissevered. Although the vitality of this plant indicated that it might attain to a fair growth, provided no other harm should befall it, such an event, however, could only be considered as a bare possibility.

A visit to the coldframes of another grower afforded a view of the effects of ruin as were displayed by part of a bed not yet replanted. Judging by the havoc presented here, the owner's opinion that his loss of stock amounted to 75 per cent of the entire first planting seemed to be well founded. By taking his estimate of shortage and allowing it to include all additional failures bound to occur among the remainder of the plants, a very conservative comprehension could be derived in respect to the plight of growers at large.

Menace to Garden Peas and Seed Potatoes

Attention was also called to depredations committed on young garden pea vines in the same locality, but the plants appeared to be fully able to withstand the injuries although the stems were badly scarred at points beneath the soil. So far as was ascertained, the stems had only suffered abrasions not much more than skin deep. The firm structure of the heart had evidently proved to be impregnable against attacks, and had therefore saved the plants from fatal damage. Search

for the enemy revealed it only in the pupal stage occurring in the soil at short distances from the plants. The finding of the pest in this form established the fact that the destructive stage, or maggot, had ceased its ravages in this field.

The work of maggots in seed potatoes could only be briefly investigated, but it certainly foreboded disaster to the planting that was first inspected. Tubers that were dug up for examination consisted in part or almost wholly of a rotten mass infested with the maggots. Reduction of the parent stock in such manner meant that the sprouts must soon die for lack of nutriment. In a field of more recent planting where the tubers had just started to sprout, no defects came to view, although the stock was found to be endangered by numbers of maggots which reveled in the decomposing cotton seeds that had been put in the rows for fertilization of the crop growth.

Infestation of Cotton Seeds used for Fertilizer

The discovery of the maggots existing among the rotting cotton seeds buried under several inches of soil incited comment in regard to the manner in which the infestation could have been initiated. The introduction of these forms could not be explained in a way to satisfactorily attribute sufficient ability on the part of the pest at any stage to gain access into such a situation. The problem, however, admitted of a simple solution which happened to be revealed through remarks ventured by the grower. He pointed out the probability that the cotton seeds had become infested with maggots previous to the time when they were scattered in the field. According to his statement, he used these seeds for fertilizer because in the first place they constituted a quantity which by exposure to rain had been rendered unfit for planting or for sale. While being cast aside in such condition, the pile of spoiled seeds had likely attracted parent flies which had then deposited their eggs in the damp decomposing mass, thus resulting in the development of maggots under very favorable circumstances.

Comments

As adult flies cannot oviposit below the surface of the ground to any depth, no maggot on hatching from an egg placed on the soil would be able to penetrate far down unless guided by the stem of a plant. By such means as the latter, the maggots can without doubt reach the tubers of potato sprouts.

In proposing an experiment for the benefit of a grower, he was asked to place a few glass jars in an inverted position over some of his failing plants for the purpose of trapping a number of flies when they should emerge from the enclosed soil after completing their develop-

ment from the maggot stage. Specimens captured in this way were desired by the writer for study, but the arrangements failed to be carried out.

However, adult flies collected in and near the coldframes on March 6, and reared ones maturing on March 26–31, from infested material consisting of earth and pea sprouts, potato tubers and cotton seeds, filled expectation of the species being *Pegomyia fusciceps* Zett.

Destruction of Other Potato Plantings

As a matter of previous record concerning the same insect, a complaint of damage to seed potatoes, accompanied by a sample of the tubers showing infested condition, was received from Valverda, Pointe Coupee parish, La., bearing the date of March 19, 1913. The sender stated that the tubers had been planted during the month before, the planting having been begun on the 18th. The fields thus planted comprised about 20 acres in the Triumph variety and 5 acres in the Irish Cobbler. All of the seed stock had been obtained from Maine and it had arrived in excellent shape. However, it was treated with formalin; and as far as could be seen, germinated nicely. A good many little sprouts duly appeared above ground but were nipped by a frost on March 16.

Upon examining the propagating tubers on the day as noted by letter, every piece of potato without exception that the planter then dug up was found by him to be infested and practically spoiled by small maggots. He further asserted that the same enemy had occurred during past years in considerable numbers on seed potatoes, but not to the extent of spoiling them. As a large part of his present plantings had been made on land that had never produced potatoes, he was at a loss to account for the general prevalence of the foe. It operated just as numerously on the plantings in such land as on others in ground where a potato crop had been grown before. The fields were said to have been well drained, the soil having remained loose and in good tilth ever after the heavy rains of the preceding week.

While acknowledging that the damage done at the time left little hope for a crop worth cultivating, yet the grower asked for information about remedies and also desired to know if any similar case where the prospective growth had been ruined had ever come to the attention of the writer or his agricultural associates. No satisfactory advice could then be given in reply since the injuries under such circumstances presented a subject concerning which no dealings had been experienced in Louisiana and but scant enlightenment was available. As was shown by the sample, decay had followed the attacks by the maggots until the combined ravages by both agents had greatly reduced the supply of nutriment in the parent stock.

Not knowing, however, but that the sprouts might yet succeed in establishing themselves, the presence of the maggots was consequently on first notice not regarded by the writer as a serious menace. But a subsequent report made by the planter, under date of April 17, conclusively affirmed the opposite of this impression. He then wrote that the results were just about what he had expected: no stand was secured at all from the impaired seed stock, though a later planting attained to perfect growth.

Adult flies, which proved to be the species, *Pegomyia fusciceps* Zett., matured on April 1–3, from the maggots received in the rotting tubers for examination.

Another loss of a planting of seed potatoes on account of attacks by maggots occurring again in Pointe Coupee parish, which complaint was made by a grower at Ventress, under date of April 1, 1915, seemed to indicate that some especially favorable condition for the pest existed in the country there. The stock was said to have been obtained from Maine, then having been planted on March 6. At the date of writing, all of it had become rotten, which state was attributed to the work of "worms." The samples submitted for examination consisted of rotten pieces of the potatoes infested by numbers of maggots. To all appearances, these larvæ represented the species *Pegomyia fusciceps* Zett., though they failed to produce adults.

The possibility that the maggots might not have been entirely to blame for the rotting of the tubers was pointed out in reply to the grower's request for information. Their occurrence may have followed decomposition induced by cold wet soil. In case the growth of sprouts had been delayed by the latter conditions, the seed had very likely started to rot before the parent flies deposited their eggs, with the result that the issuing maggots were immediately attracted to the rotting tissues. Owing to their scavenger habits, the maggots naturally reveled in the decomposed matter and therefore hastened the spoiling of the seed.

If means in accordance with a better knowledge of the pest at this time had been employed early enough to prevent the maggots from reaching the seed, the prospect of obtaining a stand of sprouts might have been insured. The most practical measures in such respects would have depended on spraying the sprouts as soon as they had appeared above ground, with a solution of lead arsenate, preferably in combination with Bordeaux mixture. But the best that could be done in case the stand of plants proved to be inadequate for a crop would be to replant the field.

Killing Young Corn

A correspondent writing from Tallulah, Madison parish, La., on April

30, 1913, sent a few young corn plants which he stated had been gathered from a field where the crop growth was being destroyed by "worms" attacking the base of the stalks. He asserted that this corn had come up to a perfect stand, but at the time of writing, a great many of the sprouts had died, while others looked unhealthy as if affected by disease. Still some appeared outwardly to be sound and vigorous although being generally found infested by the worm-like enemy. A large part of the field had already been plowed up and planted to cotton, but he had left a portion for an experiment to determine whether the plants would be able to recover and produce a crop or fail to be worth further attention.

In response to his request for an opinion regarding the outcome of the latter course, and for suggestion as to any method by which the foe might be exterminated, very little advice could be given, because preventive measures are about all that can be employed against enemies of such nature. Then the application of precautionary treatments for field crops such as corn would likely be of questionable value considering the cost of labor and material required.

His belief that the pest was a larval form of some species of beetle failed to be sustained by examination of the material furnished. Injuries to the stalks were observed to have resulted from small shallow cavities evidently caused by a scraping away of tissues on the base close to the roots. Only a few dipterous larvæ could be detected, and all occurred in the cavities of one plant. The insect was regarded as the common root maggot (*Pegomyia fusciceps* Zett.), also called the seed-corn maggot. It therefore appeared to be the real culprit responsible for the attacks.

The absence of larvæ in the other stalks given examination may have been due to the emergence of the forms from the cavities and consequent loss in transit, or else the maggots had gone into the soil for pupation before the plants were collected. The damage inflicted was entirely different from that of deeper bored injuries as are committed by the southern corn rootworm (*Diabrotica duodecempunctata* Oliv.), which insect commonly ruined early stands of corn in the central and lower sections of the state. Neither were the roots attacked nor stems bored in this case. The plants measured from 12 to 15 inches in height and had pushed out short prop roots. As not enough maggots could be secured for rearing of the species, the name as cited should be substantiated by positive determination of the insect involved.

Pest of Hotbed with Tomato and Cauliflower Seedlings

On receipt of specimens of insects taken from a hotbed, which material accompanied an inquiry forwarded from Edgard, St. John the

Baptist parish, La., January 21, 1916, an examination of them revealed a single adult fly of the species *Pegomyia fusciceps* Zett., a plump red mite which may have been an enemy of the fly, and a number of springtails, possibly *Smynthurus sp.* The transmitter thought that such insects had cut the roots of the young plants and also eaten some of the tomato and cauliflower seeds. Advice was requested as to what treatment should be given. Answer to this question is covered in extract presented under the heading of "Reference." Considering that the occurrence of the fly indicated an infestation of the bed by maggots of its kind, the cutting of the roots of the plants could well be attributed to attacks by the latter form of pest. These injuries might have been made worse by work of the springtails, which very likely did other harm, including the destruction of the seeds.

Ravages in Onions

Ravages committed by the same insect in onions were brought to attention through a report which came to hand from Paulina, St. James parish, La., dated January 22, 1916, stating that a pest in the form of a "worm" had cut into the plants at the surface of the ground. The trouble occurred in a patch of transplanted Creole onions which had been put out three weeks before on land that had produced sorghum during the preceding summer and Irish potatoes for a fall crop. Other patches of onions planted where sweet potatoes had been grown were declared to have no enemy of the kind at all. In the first plat, the foe was found by opening the little onions. It was described as a white worm of small size, measuring about one eighth of an inch in length and being no thicker than a needle.

As desired, samples of the infested onions were transmitted six days later. From specimens of the insect thus obtained, the species was identified by Mr. W. R. Walton, Federal Bureau of Entomology, through the kindness of Dr. F. H. Chittenden. The instructions furnished in regard to treatments for checking further advances of the pest emphasized the importance of pulling up and destroying all the infested onions in order to kill the maggots before they could develop into flies. Warning was given that the insect if allowed to mature would be able to reach other patches, and these adults by depositing their eggs all through the fields would be very apt to bring on a widespread infestation with the issue of a new brood of maggots.

Reference

Tucker, E. S. Stem Maggots Attacking Young Tomato Plants. 1914. Southern Farmer (Baton Rouge, La.), vol. 1, No. 9, May, p. 9.

A notice of the losses experienced by the growers at Norwood, La., contains the following remarks on control of the insect: "Practical methods of checking or preventing attacks on the tomato plants were promptly employed, and two kinds of

treatment gave promise of good results. One depended on a liberal scattering of tobacco powder on the beds. This material is claimed to serve as a fertilizer in addition to its repellent action on the maggots. The use of a trade preparation called 'Pyrox,' which was sprayed on several beds of plants, seemed to afford almost complete protection to the growth. Where such applications had been made upon plants at time of setting and later, the stock was not molested by maggots nor even cutworms, and showed no sign of disease. Growers who adopted this course secured stands of advanced stock. That the enemy was overcome by the above means is evidenced by the absence of any further complaint, and a full tomato crop is therefore believed to be assured."

A BUPRESTID HOUSEHOLD INSECT (CHRYSOPHANA PLACIDA LEC.)

By H. E. Burke, *Specialist in Forest Entomology, Branch of Forest Insects, Bureau of Entomology, U. S. Department of Agriculture*

During the past year, this species, through a slight change in habit, has become, locally at least, an injurious household insect. Normally it lives in the wood of dead limbs, tops and scars on the trunks of living trees. Fire scars and blazes are very often found to be infested in the higher mountain regions of the Rocky Mountain and Pacific states. The larvæ mine the wood riddling it with the small worm holes which are filled with the fine dustlike borings. In the average forest a good deal of damage is done to the timber of the trunks of injured standing trees.

It is not such a long step from the wood of the standing tree to the wood of window casings and door frames. This seems to be the first case reported, however, where a Buprestid normally living under the same conditions as *Chrysophana* has made the step.

In the case under observation the frames of several windows in various office buildings in Placerville, Calif., were found to be riddled by the mines of this species and adults were taken in the act of emerging from the wood. One building was erected over thirty years ago and another over twenty so the casings evidently were infested long after the buildings were erected. The work indicated that the wood had been infested and reinfested several times and probably in a number of cases the adults never left the room into which they had emerged but mated and the females oviposited in the same casings or adjoining ones. The casings appeared to be of sugar pine (*Pinus lambertiana* Dougl.).

That this species is quite adaptable in regard to host is also indicated by the fact that it is a burrower in cones. During the past few years it has been found several times in the cones of the knobcone pine (*Pinus attenuata* Lemmon). These cones remain on the tree a number of years and are hard and dry, more like a branch than the average cone.

The life-history of *Chrysophana* is very much like the life-history of

the average wood-boring Buprestid. It lives in the wood as a larva for two or three years and pupates and transforms to the adult in a pupal cell in the wood. Pupation takes place from July to October and the transformation to the adult in a few weeks afterward. The adult then rests over the winter in the pupal cell and emerges from the wood the next spring or summer, from March to September. Adults have been collected flying or crawling in the forests from March 20 to August 24.

During the past fifteen years *Chrysophana placida* has been taken by members of the Branch of Forest Insects, Bureau of Entomology, United States Department of Agriculture, in the localities and host trees listed herewith.

Distribution

California: Fallen Leaf, Pyramid Ranger Station, Placerville, Markleeville, Shingle Springs, Sterling, Yreka, Tallac, Lake Valley Ranger Station, Echo Lake, Meyers, Wrights Lake, Monumental, Vade. *Colorado:* Florissant. *Oregon:* Sumpter, Waldo, Ashland. *Utah:* Panguitch Lake, Kamas. *Washington:* Des Moines.

Host Trees

Mountain, white or silver pine (*Pinus monticola* Dougl.), sugar pine (*Pinus lambertiana* Dougl.), single leaf pinon (*Pinus monophylla* T. & T.), yellow pine (*Pinus ponderosa* Laws), rock pine (*Pinus scopulorum* Engelm.), jeffrey pine (*Pinus jeffreyi* Oreg. Com.), lodgepole pine (*Pinus murrayana* Oreg. Com.), digger or gray pine (*Pinus sabiniana* Dougl.), knobcone pine (*Pinus attenuata* Lemmon), black hemlock (*Tsuga mertensiana* Carr.), Douglas spruce (*Pseudotsuga taxifolia* Britton), Alpine fir (*Abies lasiocarpa* Nutt.), white fir (*Abies concolor* Parry), red fir (*Abies magnifica* Murr.), giant arborvitae or western red cedar (*Thuja plicata* Don.).

CONTRIBUTION TO THE LIFE-HISTORY AND HABITS OF THE SPINOSE EAR TICK, ORNITHODOROS MEGNINI

By William B. Herms, *University of California*

The spinose ear tick presents a problem of considerable importance to the animal husbandryman in nearly all of the southern half of California, particularly in the Imperial Valley where calves become seriously infested and die from what the ranchers call tick fever. Experiments and field observations on this species have been carried on more or less continuously by the University of California Laboratory of Parasitology during the past three or four years. From our records it would seem that few if any warm-blooded animals coming within the reach of this tick are exempt from attack. Calves evidently are most liable and suffer most severely, many dying from the effects.

Infested calves shake the head vigorously, become emaciated, often race about madly until completely exhausted. The ears become inflamed and the secretion of wax is greatly stimulated. Deafness is said often to result in infested horses and mules.

The following account is by a man whose ear was inhabited by a tick of this species. This account is worthy of note because the course of events is here rather accurately given, together with the sensations aroused and other matters of interest. Mr. L., writing from Lancaster (California), states: "I left Berkeley with a horse and wagon on the 3d of September (1915) and drove about four hundred miles to Lancaster, Los Angeles County. I slept on the ground every night except one, arriving here on September 15. Some of my camping places were in, others along-side of, cattle ranges or pastures. One of the places I discovered before morning to be a regular camp for twenty or thirty cattle of all sizes. This is where I did not sleep on the ground. The cattle came in after I had made camp about dark and it was too late for me to find another place, so I moved my bed into a small shack, near the barn with old straw on the floor, which was about a foot above the ground. Still I was right among the cattle. This was the night of September 5, at Corrall Hollow, east of Livermore. The last night out, September 15, I slept on land that is used only for grazing and have been working on similar ground ever since; however, there are only a few cattle on the range. My other sleeping places were mostly along the roadside, and sometimes cattle were around. At other places there were none and I think there have been no cattle near the house I live in for several years, or perhaps a few passing near it once in a while." Our records show that Mr. L. went through territory where the spinose ear tick occurs. In his first letter, dated December 10, 1915, he says "I am sending you . . . a bug . . . which came out of my ear, and which was living there probably six or seven weeks. . . . About six or eight weeks ago I began hearing unusual noises in my left ear. Sometimes hours would pass without hearing them; sometimes every few minutes, either day or night. The noise would saw awhile without any regularity as to time or duration. I could feel no movement in my ear like anything alive. Finally I thought I had better have it examined, so went to a local physician and told him I thought something was in my ear. He examined it and said 'Yes, there is something in there. I'll see what it is and what I can do for it.' After prodding around awhile he asked, 'What do you suppose that thing is in there?' I replied that I did not know. 'Well, it is a live bug, but I killed it.' He pulled out what looked like a clot of good red blood, about the size of a small pea, mixed with small bits of soft membrane. Then he

washed the ear with peroxide and gave me the syringe and a bottle of peroxide and told me to wash it a couple of times a day for two or three days. . . . I used the peroxide as directed, but the noises did not seem to stop and soon I concluded that they were about as before. . . . Finally I made up a dose of peroxide as hot as my ear would stand and about the third or fourth shot with the syringe this ugly thing came tumbling onto the ground, and the ear has been apparently alright ever since. This was last Tuesday, December 9, nine or ten days after the doctor did his job."

The above letter furnishes evidence to the effect that the tick entered the ear of the man while sleeping on the ground sometime between the third and fifteenth of September. From what is already known of the habits of the species, the tick almost certainly entered his ear as a larva. The specimen which left the ear of the patient December 9 was a full grown female. The time was, therefore, about nine weeks. This specimen remained alive without food in a small shell vial on the writer's desk until about December 1, 1916, nearly a year, during which time there were no further molts.

Oviposition

In order to ascertain the exact time expiring between the last molt and the deposition of eggs, a number of females previous to the final molt, were placed in Petri dishes with one or more males and kept in an insectary at 26°±3° C. except female No. 3 (see table) which, after about 60 days, was subjected to temperature as low as 0° C. The following table shows the result of this experiment.

Table I.—Showing Time Required between Final Molt and Oviposition, also Date of Copulation, Number of Ova

No.	Date Molted	Date Placed with Male	Date of Copulation	Date of Oviposition	No. of Ova Deposited	Days between Copulation and Oviposition
1	10/22/15	10/23/15	10/23/15	11/ 6/15 11/ 8	10 44 } 54	14
2	10/24/15	10/27/15	Not observed	11/24/15	186	28(?)
3	10/24/15	10/27/15	10/2[illegible]/15	11/27/15 12/2 12/ 3 12/ 4 12/ 6 12/ 8 12/20 3/24/16 4/13 4/30	7 12 19 5 88 94 43 166 103 25 } 562	31
4	10/19/15	10/21/15	Not observed	12/ 5/15	7	37(?)
5	10/23/15	10/23/15	10/25/15	12/ 6/15 4/16/16 4/27	117 Not counted Not counted	42
6	10/24/15	10/30/15	11/ 5/15	3/15/16 4/1	25 Not counted	100
7	10/20/15	10/30/15	Not observed		No ova	—

An examination of Table I shows that copulation took place readily within a day or two after the last molt, and that in six cases egg deposition began in from 14 to 42 days after copulation or from 15 to 44 days after the last molt, with the number of ova ranging from 7 to 562. The longest period of oviposition noted was 155 days or 189 days after molting.

Incubation Period

Unfortunately a careful record of all egg layings was not kept, but the records made in this connection are of interest nevertheless (see Table II).

Table II.—Showing Incubation Period for Ova of Ornithodoros megnini

Date of Oviposition	Date Hatched	Incubation Period	Temperature
11/ 8/15	12/1/15	23 days	Room temperature 21° C. (steam heat regulated by thermostat)
11/24/15	12/11/15 to 12/14/15	18 to 21 days	Ditto
12/ 2/15	12/22/15 to 12/24/15	20 to 22 days	Ditto

The above table though based on few observations shows that it is possible to secure oviposition during the winter months (November and December) and that the eggs hatch in a room temperature of about 21° C., requiring from 18 to 23 days incubation.

Longevity of Larvæ

In a series of experiments in which the larvæ were kept in darkened receptacles at room temperature, during the months of November, December and January it was found that the range of longevity was from 19 days, the shortest, to 63 days, the longest, with an average of 44 days. This series included seven sets of larvæ hatching during a period of 32 days.[1]

Conclusions

The spinose ear tick, *Ornithodoros megnini*, enters the ears of both man and beast causing losses particularly in calves.

Oviposition and emergence of larvæ may take place during the winter months, November, December and January, under laboratory conditions. It should be borne in mind that under field conditions this takes place during the summer and autumn months.

The adult female may live 355 days without food in a glass vial at room temperature.

[1] The writer wishes to acknowledge the assistance of Mr. M. H. Ray, a student in parasitology, who deserves much credit for his patience and care.

Copulation takes place within a day or two after the final molt.

Oviposition occurs in from 14 to 42 days after copulation with a maximum period of oviposition of 155 days.

The number of ova per female ranged from 7 to 562.

The incubation period at room temperature ranged from 18 to 23 days.

The longevity of larvæ ranged from 19 to 63 days with an average of 44 days.

A FLY CONTROL EXHIBIT

By C. W. Howard

In the autumn of 1915 it fell by lot to the writer to prepare for the State Fair, the major portion of the exhibit of the Division of Economic Zoölogy, of the Agricultural Experiment Station. The task seemed difficult, for in years past we had nearly exhausted the possibilities of preparing a new and interesting display of destructive insects. But as we have been trying for some time to impress upon our rural and farming population, certain facts about house-fly control, this seemed to be the opportunity to press home some of these facts in a telling way.

In preparing the exhibit, we had in mind the fact that fly elimination on the farm is extremely difficult, and that especial attention must also be given to sanitary arrangements, as well as to actual fly control in order to prevent disease transmission. Sanitation has been sadly neglected on most Minnesota farms, but the more progressive farmers are awakening to its necessity and are ready for suggestions.

The exhibit was called, "The Flyless Farm." A farmstead about 10 x 15 feet was laid out. The Division of Farm Management was called upon to advise as to the proper relation of the buildings, and the Division of Engineering for plans for the buildings. The entire exhibit was, therefore, correct in every detail and in accordance with the recommendations which the Experiment Station is sending out to farmers.

For the actual construction of the buildings, etc., we were fortunate in securing the services of one of our students, who is unusually apt at mechanical work. "Compo-board" served admirably as constructive material. The buildings were so made as to be collapsible and easily packed for transportation. They were of large size, built to a scale of one-half inch, the house for example being 14 x 15 inches, and the horse barn 18 x 25 inches, so that every detail could be practically perfect. This accuracy of details fixed the attention of many observers. A large green painted canvas covered the table on which the exhibit was placed, with the roadways marked out in gray.

The following buildings were shown: dwelling, dairy barn, horse barn, hog house, milk house, and outdoor toilet. The only necessary farm building lacking was the poultry house. Every building was fitted with screens over windows and doors, and the hog house had swinging doors into the run-ways, with miniature pigs passing through. At the door of the dairy barn was shown a miniature manure spreader receiving a load of manure from the manure carrier and ready for the daily removal to the field. On the other side was a model of a maggot-trap. At the horse barn were shown manure bin and manure closet for we knew that many of our visitors would be from villages and towns where such outfits could be used.

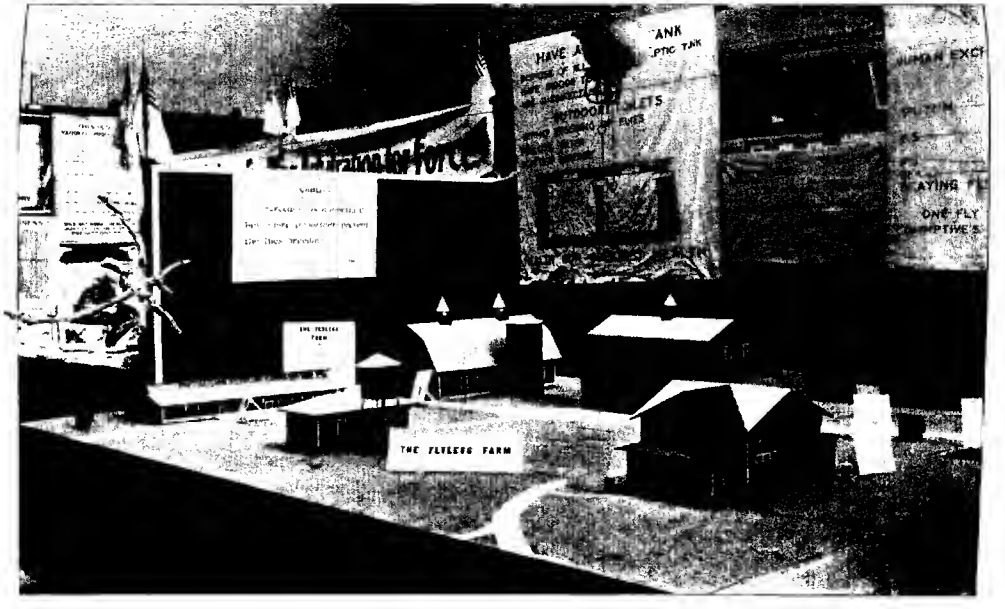
The milk house was removed from the stables, and beside the water tank. Windows and doors were fitted with screens, and a screened enclosure contained shelves on which pails and tins were airing. The dwelling, besides screens on windows and doors, was provided with screened porches, both front and rear. At the back door was a garbage tin. A portion of one side of the house was removed to show connection of kitchen sink and washbowl, bathtub and closet in the bath room, with a sewage system. At a convenient distance from the house, a model Imhoff septic tank was let into an excavation, connections to the house and outlet being indicated. The outdoor toilet was a perfect model of a flyproof, sanitary privy, of the bucket type.

An abundance of labels explaning every detail and a leaflet, which had been prepared on fly control to accompany this exhibit, gave full information to those who did not wish to ask questions of the attendants.

The success of this exhibit was much greater than had been anticipated and many people went away with a definite idea about farm sanitation, especially about the construction and use of septic tanks.

The cost of the models was not very great, approximately six weeks were required for construction. Labor and material have totaled about $200, the cost of publishing the fly leaflet being in excess of this. This year the flyless farm has been again exhibited at the State Fair, at the request of the Women's Federated Clubs, and will also visit several county fairs.

We are making additions to it as they suggest themselves. For example, this year we have added a model of a mosquito-proof water tank at the corner of the house. The models are very durable and we hope will last long enough to visit every county fair in the state on their mission of better farm sanitation. To the average individual in Minnesota, whether rural or city dweller, it conveys more practical information on the house-fly question, than all the leaflets we have ever printed.



Minnesota Fly Control Exhibit

A FEW NOTES FROM KENTUCKY

By H. GARMAN, *Lexington, Ky.*

With a very cold, cloudy, backward spring, insect problems have not come to the front in Kentucky as early as usual, but several insect pests have already claimed some attention.

The Hessian fly is being closely studied in the western end of Kentucky with a view to learning more of variations in its life-history from season to season. The adults have been abroad since March 25 on wheat sown September 28 and are numerous in that end of the state, though the wheat itself was in many places destroyed by frost and the promise for a crop is very unsatisfactory. The evidence secured by us last fall and this spring shows that owing to the influence of excessive drought in delaying volunteer wheat and also in keeping farmers from planting early, few or no adults emerged in the fall of 1916. But when flaxseeds were brought indoors at that time the adults came out in a few days, showing that they were ready and would probably have emerged in 1916 as they appeared to have done in 1915, if we had had a week more of warm weather. As it chanced, cold weather put a stop to their activities in October. With the first warm days they came out this spring. I am still of the opinion that a brood of adults matures in the fall in this region during some of our long open falls. We hope to solve this question next fall.

The buffalo gnat (*Simulium pecuarum*) was abundant for a day or two in one county in Western Kentucky this spring. Some mules were actually killed by it. It disappeared as suddenly as it came, leaving farmers wondering as to where it came from, some of them holding that it came from some distance on a cold west wind. Examination of the locality showed it entirely unsuited to the breeding of the insect. The streams are small, and dry up completely, it is said, in summer. Some pupæ of a Simulium were collected at the time in partly submerged willow in the edge of a creek. These appear to be of the type of *S. venustum*, though a determination based upon the pupal characters seems not to be safe in view of present knowledge of the life-history of our species. As a matter of fact, in the two cases of outbreaks of buffalo gnats which I have investigated in Kentucky, neither larvæ nor pupæ that can be considered as belonging to the species were discovered, and the local conditions were not such as have been described as suitable for the breeding of the pest. It is evident that there is much yet to learn about the life-history and habits of the buffalo gnat.

The Red-legged Flea-beetle (*Crepidodera rufipes*) of Peach Trees.—The first instance of injury from this introduced pest in Kentucky came to my attention in the shape of specimens sent me from Lewis County, May 4, 1917, where they were reported as gnawing the leaves badly, and as being very difficult to destroy with the customary doses of arsenate of lead.

We were made to realize keenly the defects in our nursery inspection law recently by a sudden demand for a quarantine against the white pine blister rust. The Kentucky law makes no provision for quarantines, and in fact does not provide for any rules or regulations by any state official under which a quarantine may be established. With a federal quarantine of territory of which Kentucky is a part, state legislation is not now so badly needed, but we should have been able to act at once. The law needs amending to provide for such emergencies.

American foulbrood is giving us much trouble, especially about the edges of cities where a good many people keep bees, but handle them badly. The spread of the disease among such beekeepers is rapid and in many cases results in a complete extermination of the colonies. The inspection of apiaries will some day be demanded by our people. The rapid growth of interest in beekeeping in the state, and the pronounced success of some of our commercial apiarists and queen rearers, is calling attention to this need, and we expect it to result soon in a good law with ample provision for enforcing it.

It may be of interest to collectors of Coleoptera to know that the introduced Tenebrionid (*Blaps mucronata*) has recently appeared in some numbers in grain warehouses at Lexington. Dozens were secured January 20, 1916, in the basement of a seed warehouse under sacks and among grain refuse about the floors. It was subsequently found about a dump at the edge of Lexington where it had probably been thrown with refuse from buildings. The first specimens observed here were collected in 1914. We cannot see that it is doing serious mischief, though it feeds on grain. The eggs and larvæ have been secured, but have not yet been followed to maturity.

The wheat fly (*Oscinis variabilis*)[1] emerged in one of our cages this spring, May 2, developing from wheat planted October 2, 1916, taken up last fall and kept out of doors at Lexington until the insects ap-

[1] When it was first discovered on wheat in Kentucky the writer did not feel satisfied that it was Loew's *O. variabilis* for the reason that it did not agree well with his description. Professor Aldrich, in his List, placed it under *O. carbonaria* Loew, though apparently with some doubt. He has recently examined some of my material and now pronounces it *O. pusilla* Meigen.

peared. It would seem, therefore, that its eggs may be laid very late in the fall.

We are still working on the locust borer (*Cyllene robiniæ*) and have some problems connected with its injuries and ecology to work out during the season now opening.

AN APHIS PARASITE FEEDING AT PUNCTURE HOLES MADE BY THE OVIPOSITOR

By L. P. ROCKWOOD, *U. S. Bureau of Entomology, Forest Grove, Oregon*

Having had my attention called by Dr. L. O. Howard to the fact that probably no observation has yet been published on any parasite of an aphis feeding on the juices of the host at puncture holes made by the ovipositor, I present the following observation as of interest for this reason.

On September 8, 1916, while examining red clover stems infested with *Aphis bakeri* Cowen, an *Aphelinus*, previously reared from this aphis and recently described by Dr. L. O. Howard in the Proceedings of the Biological Society of Washington, vol. 30, p. 77, as *Aphelinus lapisligni* n. sp., was found in the midst of a colony of *A. bakeri* beneath a bract on a clover stem. The *Aphelinus* was observed to approach a medium-sized aphis which was feeding. The parasite examined the aphis with its antennæ, then walked away about its own length, turned its back to the aphis and exserted its long semi-transparent ovipositor which it plunged into the aphis, a little to one side of the anus. The *Aphelinus* kept its ovipositor inserted during a space of several seconds, and during that time backed up toward the aphis, apparently plunging the ovipositor deeper into the wound. The aphis showed some discomfort and excreted a drop of honey dew from the anus. The parasite concluded its operation, walked off a few of its own lengths and returned to repeat the performance during a much shorter period. The operation was repeated three times while under observation, the ovipositor being inserted each time in approximately the same place. Then the *Aphelinus* returned and placed its mouth to the wound, and apparently fed on the juices of the aphis for more than a minute. The aphis was not dissected so it is not known whether one or more eggs were laid in the aphis.

For instances of this feeding habit with other parasitic Hymenoptera and other hosts, consult the paper entitled "On the Habit with Certain Chalcidoidea of Feeding at Puncture Holes made by the Ovipositor," by L. O. Howard, JOURNAL OF ECONOMIC ENTOMOLOGY, vol. III, No. 3, June, 1910, pages 357–360.

EASTERN APHIDS, NEW OR LITTLE KNOWN, PART I[1]

By Edith M. Patch

The present paper resulted from the examination of the collection of Connecticut aphids lent by Dr. W. E. Britton. Several undescribed species were found, some of which were well known in certain collections without having made their way into literature. A few of these are briefly described by the writer of Part I, and the others are presented by Mr. Baker in Part II as he was already at work on the groups those species represent, and kindly undertook their examination.

Most of the species are described with reference to material from Connecticut, though a few not yet reported from that state are included.

Aphis viburniphila n. sp.

(Fig. 20, c, d, e)

Alate Vivipara: Head, eyes, and antenna black, antennal joint III and VI approximately same length and sub-equal to IV + V, III with about 20 sensoria extending whole length, IV with from none to several sensoria, beak extends to second coxæ; thorax black, prothoracic tubercles prominent, wings with rather heavy dark veins; abdomen glabrous, dark red to reddish brown both above and beneath, caudal portion black, four lateral dusky spots cephalad of the cornicles, cornicles cylindrical, black, about twice the length of tarsi, imbrications serrate; cauda and cornicle, black, paler at base; lateral tubercles present, that between cornicle and cauda being prominent.

Apterous Vivipara: Head black, antenna dark except proximal III which is pale, III with about 15 sensoria which are more numerous on distal half, IV with or without sensoria; thorax reddish brown with prothoracic tubercles: abdomen bright reddish brown with two transverse black stripes cephalad the cauda, cornicles and cauda black.

Apterous Ovipara: Tan-colored form with black cornicles which are slightly more than half as long as in the apterous vivipara; antenna without secondary sensoria; hind tibia but slightly enlarged with a very few sensoria on distal half.

The cotype localities are Orono, Maine, where the writer has collected this interesting aphid for ten years; New Haven, Connecticut, where it has been taken by Dr. W. E. Britton and Mr. H. D. Clark; and Plummer's Island, Maryland, and Great Falls, Virginia, where Mr. W. L. McAtee has collected it, specimens from all these places being examined at time of preparing the description. Mr. J. J. Davis writes (March 22, 1916) that he has this species from St. Louis, and from Chicago where it is sometimes a serious pest of the *Viburnum* in parks.

In Maine this species is present on *Viburnums* during the entire year, being conspicuously abundant during June, July and August. It

[1] Papers from the Maine Agricultural Experiment Station: Entomology No. 88.

attacks cyme, both during flower time and early fruiting, ventral leaves and the tender twigs. The insects are gregarious and their colonies are frequently wellnigh exterminated by hymenopterous parasites. It is sometimes present on the same *Viburnums* with *Aphis viburnicola* Gillette, *A. rumicis* Linn, and *Macrosiphum viticola* Thomas, but there is no need of confusing it with any of these species.

On August 24, 1912, and August 26, 1915, at Orono oviparous females were found to be numerous feeding at berry clusters and depositing eggs thickly in axil of leaf and between terminal stems. Males have not yet been recorded. The time of the hatching of the stem female has not been observed.

The writer has seen specimens from *Viburnum acerifolium* L., Maine and Maryland; *V. cassinoides* L., Maine; *V. dentatum* L., Maine and Virginia; *V. opulus* L., Maine and Connecticut; *V. plicatum*, Connecticut; *V. pubescens* Pursh, Maryland.

APHIS RUMEXICOLENS n. sp.

(Fig. 20, f, g)

ALATE VIVIPARA: Antenna 6-jointed, on no frontal tubercle, III with about 14 sensoria irregularly placed along whole length, V shorter than IV, VI longer than III; beak short, not or scarcely reaching second coxa; venation rather heavy but not shadowed; abdomen with black dorsum and large black lateral spots, cornicle shorter than tarsus or cauda, slightly bulging; cauda broad and blunt, about the length of tarsus but up-turned and appearing shorter, with a pair of dorsal tubercles near base.

APTEROUS VIVIPARA: Antenna 6-jointed, III without sensoria, base of VI subequal to V; beak short not reaching second coxa: abdomen not showing in alcoholic mount the black maculations of the alate form, cornicle shorter than tarsus, not longer than base of VI, thick at base and abruptly narrowing, tip with flare.

The cotype locality is Wallingford, Connecticut, where a collection of apterous and alate vivipara and pupal nymphs was made June 9, 1913, from *Rumex acetosella* L., by Dr. W. E. Britton.

It is needless to say that this is no typical *Aphis*, but it does not seem to slip into any of the several genera newly erected from *Aphis* and the writer hesitates to contribute to the modern tendency of establishing new genera on specific characters,—q. conservatism which has disadvantages of its own, it must be confessed.

APHIS SALICETI Kaltenbach

(Fig. 20, a, b)

This insect has not previously been recorded for America. It was collected at Orono during late June and July, being abundant upon fennel (*Foeniculum vulgare*), July 25 upon *Heracleum lanatum*, and August 12 upon cultivated parsnip in 1913. The same year it was taken on cultivated parsnip July 25 at Machias, Maine, and on willow

(*Salix sp.*) July 30 at Cherryfield, Maine. Specimens have recently been submitted to the writer for determination which were collected from parsnip at New Haven, Connecticut, July 13, 1909, by Mr. A. I. Bourne.

The willow seems to have been the only host previously known for this species. That it accepts members of the *Umbelliferae* also is evident from these collections but the details of its life-cycle have not been worked out. This is "*A. saliceti* Kalt." of Buckton and of Theobald 1912, but evidently not of all writers.

Aphis davisi, new name

It seems necessary at this time to rename the aphid recorded as *Aphis populifoliæ* Fitch by Mr. Davis (Journal Economic Entomology, vol. 3, p. 489) as, according to Mr. Baker, *populifoliæ* Fitch belongs under *Pterocomma.*

Prociphilus xylostei de Geer

(Fig. 20, h, i)

A colony of what seems to be the first collection of this species for America was taken from *Lonicera* at Orono, Maine, July 7, 1914. A single stem female with her progeny of pupal nymphs and newly winged spring migrants were collected. The migrants apparently accord in structural characters with specimens of this species taken in Sweden by Albert Tullgren, and seen by the writer, though they are smaller.

Prociphilus approximatus n. sp.

Alate Vivipara: Head with dorsal wax plates large, sub-circular and separated by fully half their width; beak extending to or a little beyond second coxæ, antennal segment III with ± 25 sensoria, IV with ± 8, V with ±12, VI with ±12, IV about as long as tarsus exclusive of claw, shorter than V or VI which are sub-equal, III a little longer than V + VI; thorax with wax plates large, clear cut, approximate, being separated only by a straight line; wings not unusual for this genus; abdomen with large lateral wax plates covering nearly the width of the segment, and large dorsal wax plates.

The cotype material including pupæ and newly molted alates was collected from White Ash, Hawleyville, Connecticut, June 19, 1914, by Dr. W. E. Britton. It is a distinctive species especially with reference to the large approximate thoracic wax plates, and if migratory offers an interesting life-cycle problem.

Lachnus rosæ Cholodkovsky

(Fig. 20, j)

A *Lachnus* which accords too well with the species indicated to entitle it to another name was made July 12, 1915, from wild rose near

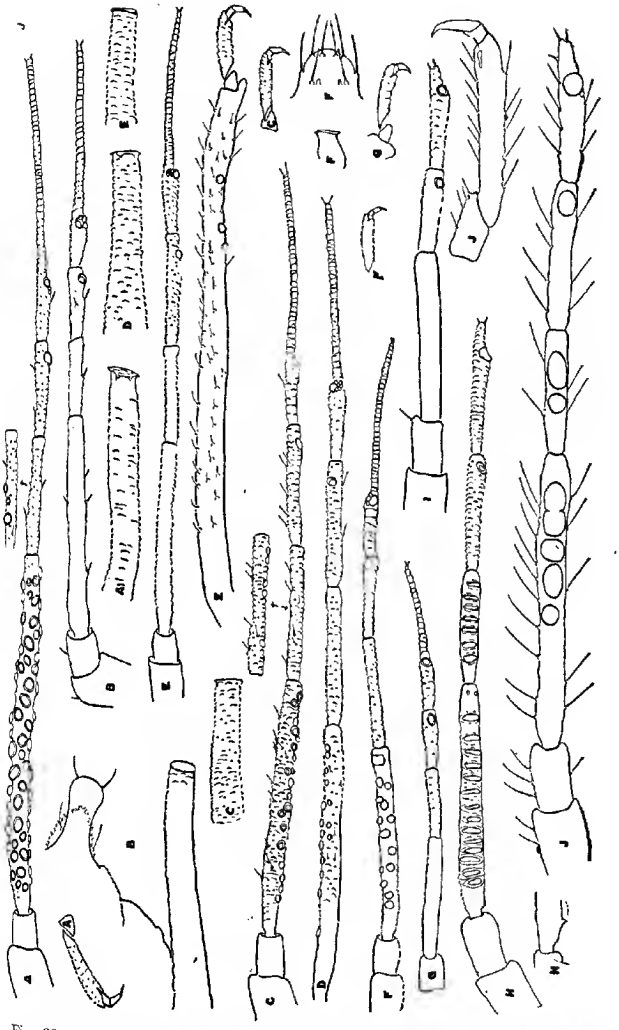


Fig. 20. *A*, *Aphis saliceti*, alate vivipara. *B*, *A. saliceti*, apterous vivipara. *C*, *A. viburniphila*, alate vivipara. *D*, *A. viburniphila*, apterous vivipara. *E*, *A. viburniphila*, apterous ovipara. *F*, *A. rumexicolens*, alate vivipara. *G*, *A. rumexicolens*, apterous vivipara. *H*. *Prociphilus xylostei*, alate vivipara. *I*, *P. xylostei*, apterous vivipara. *J*, *Lachnus rosæ*, alate vivipara.

Orono. The colony was feeding on the stem and was accompanied by ants. Alate and apterous females and nymphs were taken at this time. Later, August 24, in the same locality an apterous female and nymph of this aphid were found. The body of the apterous female was glistening bronze and thickly hairy. The nymph was cinnamon brown. This has not been compared with actual specimens from Russia, but the figures accompanying the original description seem in this case adequate for determination. There is no previous record of this species for America.

EASTERN APHIDS, NEW OR LITTLE KNOWN, PART II

By Arthur C. Baker, *Bureau of Entomology, Washington, D. C.*

Genus Myzocallis Pass

Myzocallis punctatellus (Fitch). (1855, p. 165.) This species has been placed as a synonym of *caryella* by Oestlund (1887, p. 45). The type specimen which is in the U. S. National Museum collection proves this not to be the case. The type is not in perfect condition, having lost the abdomen, one antennæ, the unguis of the other and both hind wings. However, enough of the specimen remains to make a determination positive and this remnant has been well mounted by Mr. Pergande. The antenna remaining on the type measures as follows: III, 0.592 mm.; IV, 0.496 mm.; V, 0.368 mm. Segment III is armed with seven rather large sensoria forming a row along the segment. The vertex and crown are armed with a number of tubercles on which spines are mounted. The wings are without markings excepting a clouding around the edge of the stigma and bands of brown bordering the veins. This bordering of the veins is rather faint in the type which is no doubt somewhat faded.

Mr. Davis kindly sent me specimens of an undescribed species from the Monell collection. These specimens, No. 370 X, are undoubtedly *punctatellus*. The banding along the veins is more distinct and the specimens are in good shape. They are alate viviparous females. The following description is drawn up from the specimens.

Alate Viviparous Female: Antennæ as follows: III, 0.576 mm.; IV, 0.432 mm.; V, 0.336 mm.; VI (0.144 mm. + 0.32 mm.). Segment III, with usually five large circular sensoria in a row. Labium short. Abdomen with two pairs of very prominent finger-like tubercles and with several smaller ones. Length of the larger pair of these tubercles about 0.16 mm. Cornicles about 0.065 mm. Length of fore wing 2.56 mm. Length from vertex to tip of cauda 1.44 mm.

General color pale yellowish. Antennal segments ringed with brown at their distal extremities; tarsi, abdominal tubercles and a spot near the distal extremity of the femora dark brown; wings banded with brown as previously described.

A form occurs in a collection taken on oak at New Haven, Conn., June 27, 1913, by H. L. Trowbridge, on oak, New Haven, Conn., July 25, 1912, by J. K. Lewis, and in a collection taken on oak at Vienna, Va., August 23, 1912, by the writer. This form agrees with the specimens mentioned previously in all details excepting the markings of the wings. It is true that larger or smaller specimens show longer or shorter antennæ, but this might be expected. Among the specimens in these collections great variation is met with in the markings of the wings. In several specimens the markings have a tendency to be arranged along the veins. From this fact and the very close measurements and structural details the writer feels that the specimens may all represent the same species. He is, therefore, calling them *punctatellus*. Abundance of material may, however, prove two species present.

Myzocallis alnifoliæ Fitch. (1851, p. 67.) This species occurs throughout the Eastern States on alder and is recorded in our literature as *alni* Fab. The European insect seems to be different from our form and this is shown particularly in the oviparous female. In specimens of the oviparous female of *alni* determined by Schouteden the third segment of the antennæ is armed with prominent hairs. The other segments sometimes also have them although no sensoria are met with on the antennæ. The hind tibiæ are swollen and covered with numerous sensoria as is usual with many of such forms. *Alnifoliæ* on the other hand has no such prominent hairs on the antennæ of the oviparous forms. The third segment, however, is armed with several sensoria in all adult specimens examined by the writer. These two differences would seem to indicate that the American form is distinct from the European.

The types of *alnifoliæ* have seemingly been lost. It is most probable that they were destroyed during the years between Fitch's death and the time his collection was brought to Washington. In looking over the Fitch collection the writer found the positions in which the specimens were pined, but the specimens have disappeared. It would appear, therefore, that the determination can never be positively proven. The description, however, fits the insect well. In his notes Fitch first described the species as *Aphis alnicolens*, which name he afterwards changed. In his collection there were no specimens bearing this name.

Myzocallis californicus n. sp. Taken on *Quercus lobata* Nee, Walnut Creek, Cal., April 6, 1916, by W. M. Davidson. Although not a Eastern species the present form is here described in order that it may be included in the key of American species of the genus. It seems to be somewhat related to *fumipenellus* Fitch.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Antennæ with the following measurements: Segment III, 0.72 mm.; IV, 0.432 mm.; V, 0.352 mm.; VI (0.144 mm. + 0.16 mm.). Segment III is armed with about 4 circular sensoria considerably separated. Abdomen armed with three pairs of prominent finger-like tubercles tipped with stout hairs. Cornicles rather long and narrow for the genus, 0.112 mm. long. Cauda quite deeply bilobed, suggesting that of *fumipenellus* Fitch; cauda very distinctly knobbed. Length of forewing, 2.4 mm.; length from vertex to tip of cauda about 1.7 mm.

Color Characters: General color pale yellowish green; eyes, distal extremities of the antennal segments, the tarsi, a spot on the proximal extremities of the tibiæ and a small area on each end of the tibiæ brown. Otherwise uniform yellowish green, the eyes of the embryos showing through the abdomen as small red spots.

Described from alate viviparous females in balsam mounts.

Type in U. S. National Museum. Cat. No. 20341.

Myzocallis fumipennellus (Fitch). (1855, p. 166.) This seemingly rare species is known to the writer only from the type now in the National Museum and from the type of *caryæfoliæ* Davis, in the same collection. The two seem to be identical. Fitch's type is not entire but consists of the head and thorax with the third segment of one antenna and part of the other, the wings and the legs. The abdomen of course is shrunken. The parts remaining, however, are very characteristic and leave little doubt that the species described by Davis is the *fumipennellus* of Fitch.

Wilson placed this species in the genus Callipterus as the only American form. It is quite distinct, however, from the type of the genus, and is no doubt a *Myzocallis*. So far as the writer is aware no species of Callipterus occur in this country.

The excellent description given by Davis (1910, p. 198) has placed this species definitely in the literature and it only remains to transfer Fitch's name to his description.

Myzocallis tiliæ (L). Taken on *Tilia*, New Haven, Conn., July 14, 1909, by A. I. Bourne. Conn. No. 1–16/109. This well-known species seems to occur commonly wherever its host tree is grown. The genus Eucallipterus has been erected with this form as type. There is no doubt that the species considered without other forms shows a considerable difference from the type of Myzocallis. Three species might be separated and included in *Eucallipterus; tiliæ* L., *bellus* Walsh and *walshi* Mon. The only real character to separate *tiliæ* is the deeply bilobed nature of the anal plate as compared with the shallow bilobed anal plate of Myzocallis. Some species of Myzocallis, as *trifolii* Mon., often have a distinctly bilobed anal plate. The cauda and anal plate of *bellus* Walsh are very close indeed to those of *tiliæ* and there would be no difficulty in separating these two species from the type of Myzocallis. *Walshi* Mon. is very close in general structure to *bellus* Walsh; so close indeed, that it has by some been placed as a

synonym. Yet when we come to examine the anal plate of *walshi* we find that many specimens show a typical Myzocallis anal plate. The prothorax in *tiliæ* is somewhat different from that of most species of Myzocallis and this is also approached by *bellus* and *walshi*. Yet other species vary toward it. Here then we have the choice of placing *tiliæ* and *bellus* in Eucallipterus and most specimens of *walshi* in Myzocallis or of transferring *tiliæ* to Myzocallis wherein *bellus* was described and the other species since placed. The latter method has been adopted by the writer in that it would seem to simplify matters. The species needs no descriptive remarks since an excellent description has been given by Davis. (1909, p. 33.)

The following key will distinguish the American species of Myzocallis.

KEY TO AMERICAN SPECIES OF MYZOCALLIS

(Alate viviparous females)

1. Dorsum of abdomen with finger-like tubercles 2
   Dorsum of abdomen without such tubercles 7
2. Unguis of segment VI about equal in length to the base 3
   Unguis of VI twice as long as base ..... *punctatellus* (Fitch)
3. Cornicles long (nearly 0.112 mm.) abdomen greenish 4
   Cornicles short (0.064 mm. or less) 5
4. Segment VI less than width of head across eyes ..... *californicus* Baker
   Segment VI much longer than width of head across eyes ..... *pasaniæ* Davidson
5. Segment III of antennæ shorter than the width of head across eyes, abdominal tubercles setose and dark brown; cornicles about 0.06 mm. *fumipennellus* (Fitch)
   Segment III longer than width of head across eyes 6
6. Cornicles about 0.06 mm. long and black ..... *quercus* (Kalt.)
   Cornicles about 0.032 mm. long and not black ..... *ulmifolii* (Mon.)
7. Entire margin of wing with a rather broad dark brown band 8
   Margin of wing without such dark brown band 10
8. Unguis of segment VI more than twice as long as base, hind tibiæ yellowish *walshi* (Mon.)
   Unguis of segment VI less than twice as long as base 9
9. Antennæ distinctly annulated with dark brown; segment III with 10 to 12 oval sensoria, tips of the wing veins marked with brown ..... *tiliæ* (L.)
   Antennæ uniform yellowish or dusky; segment III with about four circular sensoria; tips of wing veins not marked with brown ..... *bellus* Walsh
10. Unguis of segment VI about equal to or less than the length of the base 11
    Unguis of segment VI considerably longer than the base 14
11. Abdomen with a number of dark spots 12
    Abdomen uniform green or yellowish green 13
12. Antennæ annulated, segment III with 4 to 8 sensoria close to base of segment *arundicolens* (Clark)
    Antennæ yellowish or dusky; segment III with a row of 10 or 12 sensoria covering about three-quarters of the segment ..... *trifolii* (Mon.)
13. Anal vein and base of cubitus and of media much heavier than the other veins of the wing ..... *alnifoliæ* (Fitch)
    Venation nearly uniform ..... *robiniæ* (Gill.)

14. Wings more or less banded or mottled with dark brown..... 15
Wings not so banded or mottled..... 16
15. Cornicles and a patch around their bases black.....*discolor* (Mon.)
Cornicles and a patch around their bases yellow.....*asclepiadis* (Mon.)
16. Unguis of segment VI three times as long as base.....*coryli* Goeta
Unguis of segment VI about twice as long as base..... 17
17. Abdomen with four rows of dark brown markings.....*castanicola* Baker
Abdomen without dark brown markings.....*punctatus* (Mon.)

N. B. *Callipterus genevii* Sanb. is a synonym of *trifolii* Mon.
Callipterus hyalinus Mon. is a synonym of *punctatus* Mon.
Callipterus castaneæ Buckton has been renamed *castanicola* n. n. Baker

Genus Monellia Oest.

Monellia costalis (Fitch). (1855, p. 165.) Taken on hickory leaves, New Haven, Conn., June 27, 1910, by W. E. Britton. Conn. No. 1–16/70.

In order to determine positively whether or not the specimens collected are this species the writer examined the Fitch collection and located the type specimen still bearing the original number mentioned in Fitch's note book. Since there was only one specimen in Fitch's collection and one specimen only referred to in his notes, there can be positively no doubt about this specimen being the type. Descriptive notes follow:

Alate Viviparous Female: Antennal segments as follows: III, 0.352 mm.; IV, 0.256 mm.; V, 0.256 mm.; VI (0.16 mm. + 0.176 mm.). Segment III with five or six oval sensoria on the swollen 0.128 mm. of the segment. Abdomen with three rather large rounded gibbous tubercles on each side of abdomen. Length of forewing 1.144 mm. Length from vertex to tip of abdomen 1.76 mm.

Color yellowish; antennæ yellow ringed with dark brown; vertex lined with dark brown and a line extending down each side from eyes to past the caudal pair of the lateral tubercles mentioned. Fore wings with a broad brown band extending along the costal margin to beyond the stigma, this band interrupted just mesad of the stigma.

Key to the American Species of Monellia

(Alate viviparous females)

1. Costal margin of wing with a broad brown band extending beyond the stigma, tibiæ yellow, antennæ annulated with brown.....*costalis* (Fitch)
Costal margin of wing without such broad band though in some cases with the costal vein brown..... 2
2. Tibiæ, antennæ and costal vein dark brown to black.....*californica* Essig
Tibiæ and costal vein yellowish, antennæ annulated with dark brown..... 3
3. Abdomen with rows of dark brown spots; the unguis of Segment VI of antennæ longer than or equal to the base.....*caryæ* (Mon.)
Abdomen without such spots; the unguis of segment VI of antennæ considerably shorter than the base.....*caryella* (Fitch)

Genus Euceraphis Walker

Euceraphis betulæ (Koch). Taken on Japanese maple, Hartford, Conn. Sept. 11, 1905, by C. N. Ruedlinger, Conn. No. 1-16/145.

This species may be distinguished by the black marking upon the abdomen, the wax pores, the color of the legs and the proportions of the antennal segments and the width of the head.

The abdomen of the alate vivipara is marked with a large quadrate more or less broken dark brown patch. Within this patch there are lighter somewhat oval areas which constitute the wax plates. These areas are composed of small circular pores very variable in number in the different plates. The hind tibiæ are light in color with the distal extremities and tarsi black. The antennal segments measure as follows: III about 1.456 mm.; IV, 1.008 mm.; V, 0.8 mm.; VI (0.256 + 0.256 mm.). The head is about 0.6 mm. in width across the eyes.

Dr. Fitch described a member of the present genus under the name of *Aphis cerasicolens.* (1851, p. 65.) The type of this species is not in good condition. It was mounted from the Fitch collection by Mr. Theo. Pergande. As far as the writer is able to tell from an examination of the specimen this name is a synonym of *betulæ.*

Euceraphis mucidus (Fitch). (1856, p. 334.) Taken on black birch, New Haven, Conn., July 1913. Conn. No. 1-16/19.

The writer has examined the specimens of this species from the Fitch collection and compared them carefully with the Connecticut material and specimens from other regions. He is thus able to give a positive determination.

Alate Viviparous Female. Morphological Characters: Antennæ about as follows though somewhat longer or shorter in larger or smaller specimens. Segment III, 1.984 mm.; IV, 1.408 mm.; V, 1056 mm.; VI (0.448 mm. + 0.384 mm.). Segment armed with a few short, stiff, spine-like hairs. Segment III, with about 30 narrow oblong transverse sensoria upon the basal half of the segment. The extreme basal portion is without sensoria and that part which is covered with sensoria is somewhat swollen. Distal segments rather strongly imbricated; width of the head across the eyes about 0.64 mm.; vertex with a few short spine-like hairs and somewhat projecting forward to the median ocellus but without tubercles or projecting areas above. Cornicles nearly 0.16 mm. long and about 0.117 mm. broad at the base. Anal plate slightly notched; tibiæ very thickly covered with minute subcircular pore-like areas which are hardly as large as the tubercles forming the bases of the hairs on these segments. Dorsum of abdomen without apparent wax gland areas. Length from vertex to tip of cauda 2.88 mm.

Color Characters: Antennæ uniform black. In the pupa some specimens show only the distal segments black. Body pale green. Abdomen without the black markings met with in *betulæ.* Wings transparent, the veins sometimes noticeably dark brown. Stigma bordered below usually with dark brown or black. Femora whitish, tibiæ and tarsi black.

Body covered with a thick powdery material. Legs and sometimes parts of body covered with flocculent mealy down which assists the insect in floating through the air.

Besides the proportions, the distinguishing characters of this species are the uniform black antennæ and the absence of markings upon the abdomen. The most important character, however, is nature of the tibiæ. What appears to be the same species as *mucidus* was described by Fitch as *Aphis pinicolens*. (1851, p. 66.) The type of this species in the U. S. National Museum is in very poor condition. The tibiæ show the large number of minute pore-like structures met with in *mucidus*. The tibiæ, however, are not uniform black as in the type of *mucidus* and in the collected material of that species. Only their tips are dark brown. This may be due to the fading of the type specimen. No collected specimens which agree in all details with this type of *pinicolens* have been seen by the writer. He therefore withholds judgment in regard to the use of the name *pinicolens*.

Euceraphis brevis n. sp. Taken on "cut-leaf" white birch, Middletown, Conn., May 3, 1906, by Morris B. Crawford, Bureau of Entomology No. 9541, and on Betula sp., Ithaca, N. Y., May 15, 1911 by E. M. Patch, Me. Exp. Sta. Acc. No. 20–11.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Antennal segments as follows: III, 1.2 mm.; IV, 0.672 mm.; V, 0.528 mm.; VI, (0.176 + 0.128 mm.). Segment III, with 18 or 20 sensoria close together upon the basal third of the segment. Distal segments imbricated; width of head across the eyes about 0.64 mm.; vertex with two slight projections above abdomen with large lateral protuberances. Cornicles about 0.128 mm. long. Anal plate entire; length from vertex to tip of cauda 2.4 mm.

Color Characters: General color greenish; antennæ shaded with dusky becoming black on the distal segments; legs with the tarsi and distal extremities of the tibiæ black. The distal extremities of the femora are also sometimes more or less black.

Described from alate viviparous females in balsam mounts.
Type in U. S. National Museum. Cat. No. 20342.

Euceraphis lineata n. sp. Taken on birch at Durham, N. H., Oct. 19, 1903, by C. M. Weed, Bureau of Entomology No. 9315 D., and on *Betula populifolia*, Orono, Me., July 21, 1906, by E. M. Patch, Me. Acc. No. 83–06.

ALATE VIVIPAROUS FEMALES: Morphological Characters: Antennæ with the following measurements: Segment III, 1.68 mm.; IV, 1.36 mm.; V, 0.928 mm.; VI (0.096 mm. + 0.4 mm.). Segment III with about 25 sensoria on the basal 0.64 mm. Width of head across the eyes 0.64 mm.; vertex without projections, antennæ rather close together. Length from vertex to tip of cauda 3.13 mm.; length of forewing 4.5 mm.; anal plate rounded or very slightly indented.

Color Characters: General color greenish yellow; antennæ dusky with blackish distal annulations on the segments; tarsi, distal extremity of labium and distal extremity of the femora and tibiæ dark brown. The tibiæ has, moreover, a longitudinal dark brown stripe extended for nearly its entire length. Abdomen without dark brown markings but with the eyes of the young showing as dark brown spots.

Described from specimens in balsam mounts.
Type in U. S. National Museum. Cat. No. 20343.

Euceraphis deducta n. sp. Taken on birch, Orono, Me., June 12, 1907, by E. M. Patch, Me. No. 4–07.

This species is easily distinguished from all others in the genus by the proportions of segment VI of the antenna.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Segment III, 1.68 mm.; IV, 0.88 mm.; V, 0.8 mm.; VI (0.48 mm. + 0.144 mm.). Segment III, with about 20 sensoria on the basal 0.56 mm. Width of head across the eyes 0.64 mm. Cornicles and anal plate normal for the genus. Length from vertex to tip of cauda 2.4 mm. Length of forewing 3.52 mm.

Color Character: Color apparently a uniform yellowish green. Antennæ, tips of femora and tibiæ and the tarsi dusky. Eyes dark brown; wings unmarked excepting the tips of the veins which are shaded with brown.

Described from specimens in balsam mounts.

Type in U. S. National Museum. Cat. No. 20344.

The following key will distinguish the American species of Euceraphis.

KEY TO THE AMERICAN SPECIES OF EUCERAPHIS

(Alate viviparous females)

1. Anal plate distinctly but not deeply bilobed. Segment III of antennæ with eight or nine sensoria ..... *flava* Davidson
   Anal plate entire or but slightly indented 2
2. Tibiæ uniform black and covered thickly with a large number of small clear pores ..... *mucidus* (Fitch)
   Tibiæ not uniform black and without such pores 3
3. Abdomen with a large dark brown patch in which are clear wax pore areas *betulæ* (Koch)
   Abdomen without such dark patch and wax pore areas 4
4. Combined length of base and unguis of segment VI about equal to half of the diameter of the head across the eyes ..... *brevis* Baker
   Combined length of the base and unguis of segment VI about equal to or much more than the diameter of the head across the eyes 5
5. Unguis of segment VI less than one third of the length of the base ..... *deducta* Baker
   Unguis of segment VI considerably more than two-thirds as long as the base ... 6
6. Hind tibia with a longitudinal black stripe on its outer edge; segment III with about twenty-five sensoria ..... *lineata* Baker
   Hind tibia with only the distal extremity black and segment III with about fifteen sensoria ..... *gillettei* Davidson

GENUS CALLIPTERNELLA Goot.

Callipternella annulata (Koch). Taken on *Betula populifolii* at Veazie, Me., by E. M. Patch, July 22, 1909. Maine No. 82–09. On white birch, New Haven, Conn., July 7, 1909, by A. I. Bourne, Conn. No. 1–16/142. On birch, New Haven, Conn., by A. B. C., June 28, 1911, Conn. No. 1–16/18 and on birch at Madison, Wis., by J. J. Davis, June 7, 1913. What is evidently the same species was mentioned by Gillette (1910) as occurring upon Birch. Vander Goot (1913, p. 113) has placed this form as the same species as *annulatus* Koch.

ALATE VIVIPAROUS FEMALE: Morphological Characters: Antennæ measurements as follows: I, 0.08 mm.; II, 0.048 mm.; III, 0.48 mm.; IV, 0.288 mm.; V, 0.176 mm.; VI, (0.096 + 0.24 mm.). Segment III, armed with from 5 to 7 circular sensoria in an even row on the basal two-thirds of the segment. The sensorium at the base of the unguis of VI, rather elongate, all permanent sensoria fringed; vertex somewhat protruding and armed with prominent hairs about 0.08 mm. long. Cornicles about 0.08 mm. long, distinctly imbricated but not reticulated. Wings usual, forewing about 2 mm. long and with the radial sector faintly indicated or almost absent. Length from vertex to tip of cauda about 1.54 mm.

Color Characters: Antennæ yellowish with the base, the distal segments and the distal extremities of III and IV brown; legs, cornicles, transverse bands and lateral spots on the abdomen dark brown to black. Wing veins faintly bordered with dusky; stigma dusky with a clear central area.

APTEROUS VIVIPAROUS FEMALE: Morphological Characters: Antennal measurement as follows: I, 0.064 mm.; II, 0.048 mm.; III, 0.48 mm.; IV, 0.24 mm.; V, 0.224 mm.; VI (0.096 + 0.304 mm.). Segment III, with about 8 circular sensoria in a row on the basal two-thirds of the segment. Hairs on the vertex about 0.15 mm. long. Cornicles about 0.096 mm. long, imbricated, not reticulate. Length from vertex to tip of cauda about 1.92 mm. Abdominal hairs of about equal length with those on the vertex. Dorsum of abdomen covered with minute projections giving it an almost granular appearance.

Color Characters: General appearance dark brown. Antennal segments III and IV with dark distal extremities, the distal portions of the antennæ entirely dark. Legs dark brown. Head and thorax with large dark brown area. Abdomen marked with large dark brown lateral patches and with transverse dorsal bands of dark brown one on each segment. Remainder yellowish.

GENUS CHAITOPHORUS Koch.

Chaitophorus lyropicta Kess. Taken on the Norway maple, Meriden, Conn., June 26, 1912, by Louis A. Guidebrod. Conn. No. 1-16/14.

This species is abundant upon the Norway maple throughout the eastern section of the United States. The insect is usually considered in America under the name of *aceris*. It may be distinguished by the proportions of the sixth segment of the antennæ. The species varies considerably in size; the antennæ of the alate vivipara averaging about as follows: III, 0.592 mm.; IV, 0.368 mm.; V, 0.32 mm.; VI (0.112 mm. + 0.512 mm.). Segment III is armed with a more or less even row of from 4 to 9 sensoria.

So far as the writer has been able to discover this species never produces dimorphs.

Chaitophorus americanus n. sp. Taken on sugar maple, Brookfield Center, Conn., May 10, 1913, by C. Holder; Conn. No. 1-16/13, on *Acer* sp., Orono, Me., June 1, 1909, by E. M. Patch; Me. No. 18-09 on *Acer circinatum* at Hoquiam, Wash., June 1903, by A. D. Hopkins and on the same tree at Hoquiam, Wash., August 1903, by H. E. Burke, Bureau of Entomology, No. 9797.

There seems to have been considerable confusion in regard to the species of Chaitophorus producing dimorphic forms. Two species

occur in Europe and two in America. The European species are *aceris* L. and *testudinatus* Thorn. Of these the latter species has dimorphs margined with lamellæ whereas the dimorphs of *aceris* are armed only with long stout hairs. The two species in this country *negundinis* Thos., and the present one both have dimorphs margined with lamellæ. *Negundinis* is found upon the Manitoba maple (*Acer negundo*), whereas *americanus* feeds on the trees mentioned previously. The two species are easily distinguished.

Alate Viviparous Female: Morphological Characters: Antennæ showing considerable variation, but being about as follows: Segment III, 0.72 mm.; IV, 0.44 mm.; V, 0.34 mm.; VI (0.128 mm. + 0.368 mm.). Segment III, armed with from 18 to 24 irregularly placed sensoria which often give the segment a more or less swollen appearance. Antennal hairs long and prominent; about 0.16 mm. on Segment III. Cornicles about 0.24 mm. long and covered with reticulate areas; length from vertex to tip of cauda 3.1 mm.

Color Characters: General color dark green. Head, antennæ, thoracic lobes, sternal plate and cornicles black. Abdomen with a row of transverse black bands on the dorsum and with a row of more or less circular black spots along the margin.

Dimorph: Morphological Characters: Antennal segments as follows: III, 0.16 mm.; IV (0.064 mm. + 0.24 mm.). First segment large, projecting forward; vertex and entire margin of the body with the exception of the lateral margins of the head covered with a row of lamellæ. On the lateral margins of the head the lamellæ are replaced by lanceolate spines. Similar spines also occur upon the outer margins of the legs; dorsum apparently without plate-like structures.

Color Characters: Pale greenish with red-brown eyes.

Described from specimens in balsam mounts. Type in U. S. National Museum. Cat. No. 20345.

Chaitophorus viminalis Mon. (1879, p. 31.) Taken on *Populus grandidentata*, New Haven, Conn., June 29, 1914, by M. P. Zappe. Conn. No. 1–16/24.

A study of the type of this species kindly sent to the writer by Mr. J. J. Davis, and numerous specimens from different localities proves that the species always possesses a granular surface on the skin, although this granulation varies considerably in degree. The color also varies from a light green to a dark brown.

Chaitophorus nigræ Oest. (1887, p. 40.) Taken on willow at Galesville, Conn., July 15, 1909, by B. H. Walden. Conn. No. 1–16/125.

In studying a series of specimens thought to be this species it was noted that the reticulate marking of the skin was a constant character. Professor Oestlund kindly examined his type and informed the writer that this character is present in the type. It seems, therefore, that *nigræ* may be separated from *viminalis* on this character and on the sensoria. The type of *cordata* Wms., proves it to be the same species.

Chaitophorus bruneri Wms. (1910, p. 25.) Taken on poplar,

New Haven, Conn., July 8, 1909, by A. I. Bourne. Conn. No. 1–16/132.

This species is very close indeed to *populicola* Thos., as that insect is at present understood. A large series of the latter species shows considerable variation and a more thorough study should be made of bred material. The co-types of *bruneri* in the National Museum collection consist of alate forms and apterous females. The principal differences noted between these types and the average specimens of *populicola* are, apart from the size, the antennæ and the body hairs. Segment IV of the alate form has no sensoria or one, whereas in the same segment of *populicola* there are usually several. In many cases, however, this segment in specimens of *populicola* shows only one sensorium. The apterous specimens of *bruneri* on the Connecticut slide, as well as one specimen on the type slide, show hairs which are stout and notched at the tip. This character is also shown in a collection taken for *populicola* in Minnesota. All the other material of *populicola* which the writer has examined shows long normal hairs. This character of the hairs showing in such few specimens may possibly be a specific indication but the writer retains *bruneri* not on the strength of these hairs, but on account of a lack of material suitable for dissection and study in order to fix its status. The following measurements have been made from the cotypes in the National Museum collection.

ALATE VIVIPAROUS FEMALE: Antennæ as follows: Segment III, 0.416 mm. with 17 sensoria; IV, 0.224 mm.; V, 0.208 mm.; VI (0.128+0.16 mm.), Cornicles 0.112.

APTEROUS VIVIPAROUS FEMALE: Antennal segment III, 0.368 mm.; IV, 0.208 mm.; V, 0.208 mm.; VI (0.112 mm. + 0.144 mm.).

KEY TO THE AMERICAN SPECIES OF CHAITOPHORUS

(Alate viviparous females)

1. Wing veins heavily bordered with dark brown 2
   Wing veins not heavily bordered with dark brown 4
2. Antennæ with very few hairs (apterous form with thick spines) ... *quercicola* (Mon.)
   Antennæ noticeably hairy 3
3. Segment III of antennæ usually with several sensoria (apterous form with straight spine-like hairs) ..... *populicola* Thos.
   Segment III of antennæ usually with one sensorium (apterous form with notched spine-like hairs) ..... *bruneri* Wms.
4. Feeding upon species of maples 5
   Feeding upon species of willow and poplar 7
5. Segment III of antennæ with 16 to 24 sensoria somewhat irregularly placed on the basal three quarters of the segment ..... *americanus* Bkr.
   Segment III of antennæ with 4 to 9 sensoria in a more or less even row 6
6. Unguis of segment VI less than three times as long as the base .... *negundinis* Thos.
   Unguis of segment VI much more than three times as along as the base, often more than four times as long ..... *lyropicta* Kess.
7. Vertex and crown covered with reticulate areas (dorsum of apterous form reticulate) 8

Vertex and crown without reticulations but these replaced by granulations (especially on apterous form) Segment IV with 0 to 2 sensoria....*viminalis* Mon.

8. Segment IV with 4 to 6 sensoria.....*nigræ* Oest.
Segment IV with no sensoria.....*salicicola* Essig

N. B. *Chaitophorus agropyronensis* Gillette is a species of *Siphα*
Chaitophorus flabellus Sanborn is a species of *Saultusaphis*
Chaitophorus betulæ Buckton of Gillette is a species of *Callipternella*
Chaitophorus artemisiæ Gillette seems to be the same form described as *Cryptogsiphum canadensis* by Williams. It is not a Chaitophorus.
Chaitophorus spinosus Oest., is a synonym of *quercicola* Mon.
Chaitophorus cordata Wms., is a synonym of *nigrae* Oest.
Chaitophorus stevensis Sanborn is a synonym of *viminalis* Mon.
Chaitophorus delicata Patch is known only from the apterous forms and is therefore not included in the key
Chaitophorus tridentata Wlsn., the writer has not seen.

Genus Pterocomma Buckton

Pterocomma media n. sp. Taken on poplar, Manchester, Conn., Sept. 3, 1999, by A. I. Bourne Conn. No. 1-16/126 and on Carolina poplar, New Canaan, Conn., Sept. 21, 1909, by A. I. Bourne, Conn. No. 1-16/127.

Alate Viviparous Female: General appearance similar to *beulahensis* Ckll., from which it differs chiefly in the antennæ and cornicles. Antennæ as follows, III, 0.56 mm.; IV, 0.32 mm.; V, 0.272 mm.; VI (0.16 mm.+0.192 mm.). Segment III is covered with a large number of rather small circular sensoria; more distal segments without sensoria. Cornicles 0.256 mm. long, slightly stouter than those of *beulahensis*, being about 0.096 mm. in their greater diameter. They are flanged and somewhat swollen in the middle. Length of forewing 4.28 mm. Hind tarsus 0.24 mm. long, labium extending to the hind pair of coxæ. Length from vertex to tip of cauda about 3 mm. The color characters cannot be obtained from the mounted specimens and no color notes were taken.

Apterous Viviparous Female: Antennal segments as follows: III, 0.544 mm.; IV, 0.256 mm.; V, 0.24 mm.; VI (0.144 mm. + 0.176 mm.). Segments without sensoria. Cornicles 0.256 mm.; hind tarsi 0.24 mm. Labium extending almost to hind pair of coxæ; length from vertex to tip of cauda about 3 mm.

Described from specimens in balsam mounts.
Type in U. S. National Museum. Cat. No. 20346.

Key to the American Species of Pterocomma

(Alate viviparous females)

1. Cornicles without a distal flange and abruptly constricted at the distal extremity.....*flocculosa* (Weed)
Cornicles with a distal flange and not so abruptly constricted at their distal extremities..... 2
2. Cornicles about twice as long as their greatest diameter.....*smithiæ* (Mon.)
Cornicles much more than twice as long as their greatest diameter..... 3
3. Cornicles about equal in length to the hind tarsi..... 4
Cornicles much longer than the hind tarsi..... 6
4. Cornicles cylindrical, beak long.....*populea* (Kalt.)
Cornicles somewhat swollen, beak short..... 5

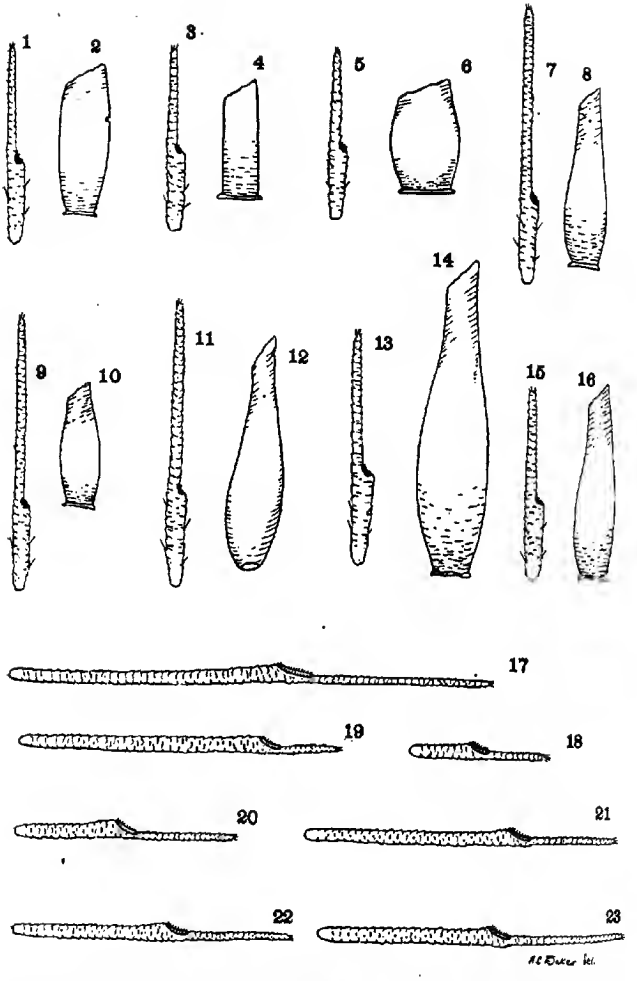


Fig. 21. *Pterocomma media.* 1, distal segment of antenna. 2, cornicle. *P. populea.* 3, distal segment of antenna. 4, cornicle. *P. smithiæ.* 5, distal segment of antenna. 6, cornicle, *P. bicolor.* 7, distal segment of antennæ. 8, cornicle. *P. beulahensis.* 9, distal segment of antenna. 10, cornicle. *P. flocculosa.* 11, distal segment of antenna. 12, cornicle. *P. salicis.* 13, distal segment of antenna. 14, cornicle. *P. populifoliæ.* 15, distal segment of antenna. 16, cornicle. *Euceraphis lineata.* 17, distal segment of antenna. *E. brevis.* 18, distal segment of antenna. *E. deducta.* 19, distal segment of antenna. *E. betulæ.* 20, distal segment of antennæ. *E. mucida.* 21, distal segment of antenna. *E. flava.* 22, distal segment of antenna. *E. gillettii.* 23, distal segment of antennæ. All figures drawn to the same scale.

5. Unguis of segment VI about twice as long as the base.....*beulahensis* (Ckll.)
Unguis of segment VI one and one-half times as long as base.....*media* Baker
6. Cornicles nearly twice as long as the hind tarsi..... 7
Cornicles much more than twice as long as the hind tarsi..... 8
7. Unguis of segment VI of antennæ about equal in length to the cornicles and about twice as long as base.....*bicolor* (Oest.)
Unguis of segment VI of antennae considerably shorter than the cornicles and not twice as long as base.....*populifoliæ* (Fitch)
8. Cornicles swollen in the middle, bright orange in color.....*salicis* (Linn.)

N. B. *Melanoxantherium antennatum* Patch is known only from the oviparous female.

Literature Referred to in Text

1851. Fitch, Asa. Cat. with references and descriptions of the insects collected and arranged for the State Cabinet of Natural History. In 4th Ann. Rept. State Cab. Nat. Hist., pp. 43–69.

1855. Fitch, Asa. Report on the Noxious and Other Insects of the State of New York. In Trans. N. Y. State Agr. Soc., vol. 14, 1854, pp. 705–880. Also printed Albany, N. Y. 176 p.

1856. Fitch, Asa. Third Report on the Noxious and Other Insects of the State of New York. In Trans. N. Y. State Agr. Soc., vol. 16, 1856, pp. 315–490.

1879. Monell, J. T. Notes on Aphididæ with Descriptions of New Species. In Bul. of the U. S. Geol. and Geograph. Survey of the Territories, vol. V, No. 1, pp. 18–32

1887. Oestlund, O. W. Synopsis of the Aphididæ of Minn. Bul. No. 4, Geol. and Nat. Hist. Survey of Minn., pp. 1–100.

1909. Davis, J. J. Studies on Aphididæ II. In Ann. Ent. Soc. Am., vol. II, pp. 39–45.

1910. Davis, J. J. Two Curious Species of Aphididæ from Illinois. In Ent. News, vol. XXI, pp. 195–200.

1910. Gillette, C. P. Plant-louse Notes—Family Aphididæ. In Jour. Econ. Ent. vol. III, p. 367.

1910. Williams, T. A. Aphididæ of Nebraska. In University Studies, vol. X, No. 2, pp. 1–91.

1913. Goot, P. van der. Zur Systematik der Aphiden. In Tijdschrift voor Entomologie, vol. 56, pp. 69–154.

1914. Davidson, W. M. Plant-louse Notes from California. In Jour. Econ. Ent., vol. VII, pp. 127–136.

THE TOMATO AND LAUREL PSYLLIDS

By E. O. Essig, *University of California, Berkeley, Cal.*

Psyllids are also known as jumping plant-lice because of their great similarity in appearance and habits to these insects and their ability to jump freely. The family *Psyllidæ* to which psyllids belong is usually placed next to the family *Aphididæ* (plant-lice), in the suborder *Homoptera* and the order *Hemiptera*. In this order are to be found many of the insects which are very injurious to crops grown in California.

There have been about fifty species described in California so it will be seen that they are not nearly as abundant as either plant-lice or scale insects. None of the native species have become of great economic importance and but one injurious species has been imported into the state.

Two species, at least, the tomato psyllid, a native of the western states, and the laurel psyllid, a native of Europe, are deemed of sufficient importance and interest to warrant a discussion of this kind.

The Tomato Psyllid

Paratrioza cockerelli (Sulc)

(Plate 20, fig. 1 and fig. 22)

This insect has been of some economic importance in Colorado for a number of years and still continues to receive consideration from agriculturists of that state. In California it is widely distributed and though little has been known regarding its economic status, it is coming to be noticed as a garden and field-crop pest in many localities. While it cannot be classed as an insect of major economic importance or even one which may ever cause great losses, it often increases in sufficient numbers to injure the infested plants and becomes a source of loss and worry to the grower.

General Appearance

Eggs (Fig. 22 D).—The eggs are exceedingly small, elongated-oval, with the attached and decidedly pointed end supported by a short petiole and the free end broadly rounded. The color is transparently white or pale greenish-yellow with a more or less definite orange-colored mass at the middle or base. The surface is normally entirely covered with a fine white powdery wax which gives a decidedly gray appearance. The powdery wax is also deposited over the surface of the leaves around the eggs and materially aids in locating them. The average length is about 0.08 mm. They are usually deposited in very great numbers upon the under surfaces of the older well-matured leaves and stand erect or slightly leaning.

Nymphs (Pl. 20, fig. 1, fig. 22 G).—The first born nymphs are very small and transparently pale yellow with orange-colored head and abdomen. The color changes somewhat as the insects mature and when ready for the last molt they are pale greenish-yellow with gray and orange markings on the dorsum. Excepting for the fringe of scale-like spines around the margins (Fig. 22 H) the bodies are perfectly naked. The bodies are very flat, broadly oval and held close to the surface of the leaves when feeding. The excrement is in the form of minute white pellets of honey-dew (Pl. 20, fig. 1) which are

deposited in sufficient numbers to serve as a ready means of locating an infestation. A slight smutting also accompanies the attacks.

ADULTS (Fig. 22 A). The mature insects are first pale green or light amber but soon become darker, there being a considerable variation in the degree of intensity of the colors. Normally the color is light amber-brown with numerous very dark brown or black markings as shown in the accompanying drawing. A very conspicuous white powdery stripe extends across the dorsal base of the abdomen, and a somewhat definite horse-shoe shaped and quite large area of the same color and covered with fine white powder occurs on the dorsal posterior two thirds of the abdomen. The legs are light amber and sparsely hairy. At the tip of the hind tibiæ there are two apical dark spines on the inside and one on the outside (Fig. 22 C). The antennæ (Fig. 22 I, J) are ten-jointed and dusky, excepting the first three and the basal half of the fourth joints. In many individuals the bases of all the joints excepting the last two are yellow. On the fourth joint near the tip is located a circular sensorium with a peculiar lid or operculum, as shown in Figure 22 B, I, while on each of joints six, eight and nine there is a single simple circular sensorium near the tip. The writer is unable to locate the one on joint two as reported by Sule. The average length of the body is about 1.8 mm.

TECHNICAL DESCRIPTION

The original technical description as given in English by Dr. Karel Sule is as follows:

Head.—Breadth of the vertex behind the eyes, 0.34 mm., with the eyes 0.52 mm., the length along the middle-line 0.16 mm., posterior margin of the vertex regularly and slightly excised, posterior angles slightly truncate, the anterior ones broadly rounded; a median line divides the vertex in two halves, either showing a distinct fovea in the middle. Antennæ filiform 1 mm. long in all; the length of single joints is: of the 1st, 2nd, 9th, and 10th 0.05 mm., of the 3rd 0.18 mm., 6th 0.13 mm., 7th 0.15 mm., and 8th 0.12 mm.; smell-organs [sensoria] present on the joints 2, 4, 6, 8, 9; that on the 4th joint is very peculiar being in the form of a hollow ball with a circular opening covered with a spoonshaped movable operculum; the other smell-organs show the form of simple pits. The 3 basal joints of the antennæ are yellow, the 4th–8th yellow, brown at their ends, the 2 last black. Frontal lobes very short, 0.06 mm. only long, rounded at the apex. Clypeus in the form of a pearhalf and not produced anteriorly. Colors of the head: the ground yellow-white, in the middle of the vertex a horseshoe-shaped large brown spot, the middle line of the vertex and the frontal lobes dark brown, the apex of the latter being lighter, clypeus yellowish-white.

Thorax: the ground color white-yellowish with a large, well defined brown marking.

Elytræ: length 2.60 mm., greatest breadth 1.00 mm.; apex in the cell. marg. I., nearly at the end of M_{1+2} and forming an acute angle; the anterior part of its margin being a little shorter than the posterior one. C+Sc, R moderately arcuate, R sinuate, ending at the beginning of the second third of M_{1+2}: M slowly arcuate with its apex

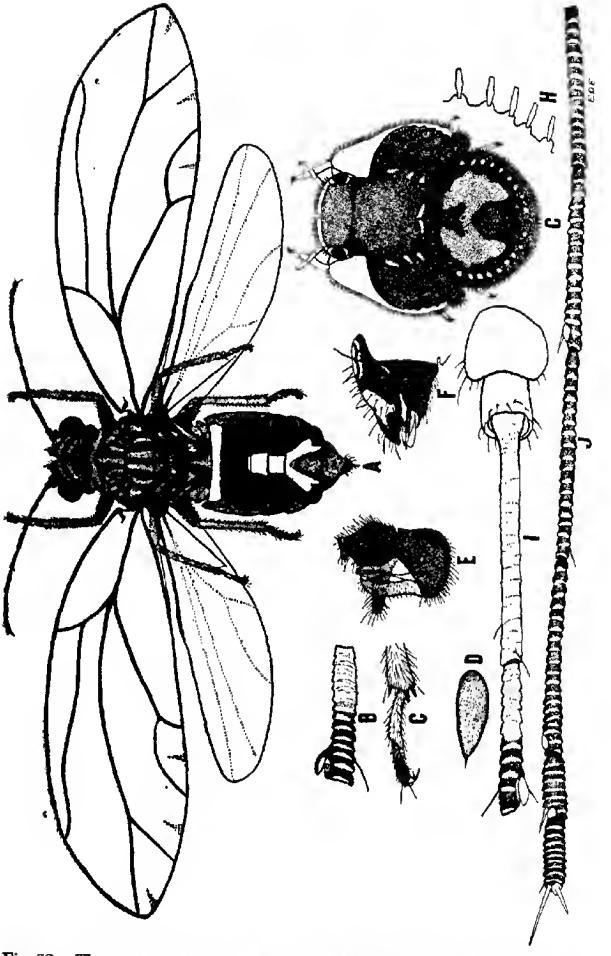


Fig. 22.—The tomato psyllid, *Paratrioza cockerelli* Sulc. *A*, adult female with wings spread; *B*, fourth joint of the antenna showing sensorium with covering or operculum; *C*, tip of the tibia showing apical spines, *D*, egg; *E*, genitalia of the male; *F*, genitalia of the female; *G*, nymph; *H*, fringe of spines around margin of nymph's body (greatly enlarged); *I*, first four joints of the antenna; *J*, last six joints of the antenna. Much enlarged. (Original).

before the middle; M_{1+2} parallel with the wing-axis M_{3+4} almost straight, Cu_1 evenly arcuate. Nervature fine, white yellowish, transversal nervules colorless. Membrane vitreous. No spines on either side of the elytra-membrane; the marginal spines only present and very distinct, forming very narrow, high groups in the cell, Rs, M_{1+2}, Cu.

Hind-wings and legs as usual in the genus.

Apex of the male abdomen: genital segment of equal breadth and height, 0.17 mm.; its posterior and inferior margin evenly arcuate, anterior half of the upper side moderately arcuate; no tubercles; hairs of moderate size, equally scattered on the surface. Color black. Forceps shows the form of a scythe with its edge anteriorly; posterior margin straight, the anterior sinuate; height 0.17 mm., breadth 0.04 mm.; if viewed from behind has the forceps also the form of a scythe, but its edge is turned inwardly and bears at the base a small obtuse tooth; above are the ends of the forceps curved like cattlehorns; hairs equally scattered on the surface. Color brownish. Anal segment 0.17 mm. high, produced posteriorly in a triangular lobe; very long setæ especially on its distal end; color brown.

Apex of the female abdomen. Anal segment viewed from above short, triangular, obliquely truncate at the end; viewed laterally on a preparate boiled in KOH and mounted in glycerin 0.28 mm. long by 0.12 mm. high; its upper margin slightly arcuate rounded at the end; inferior margin straight, slightly excised before the apex; long hairs scattered on the sides, on the upper margin and just under it short, strong, acute spiniform hairs, before the apex a few long, stout and around the anus short little hairs; on the whole surface of the segment very small, short, acute spines in rows parallel with the superior margin.—Anus O-shaped; upper length 0.20 mm., under-length 0.15 mm.; hinder-length 0.24 mm.; apex short acute, its inferior margin straight, the whole surface of the side with long scattered hairs, the hinder half of it with very short, small, acute spines in rows parallel with the posterior margin. External sheath narrowing behind with roundly truncate apex, reaching over the end of the anal segment. The inner stylets straight, obliquely truncate on the underside before the apex; the apex itself acute with two triangular teeth above. The innermost stylets triangular on their end. Color of the anal and genital segments dark brown, sometimes with a few whitish spots.

Length 2–5.3 mm. to the end of closed wings.[1]

Life-History

The winter is passed in the adult stage on evergreen food plants or in sheltered places elsewhere. Eggs are laid late in April and until late fall and early winter in the mild climate of this state. The broods are exceedingly uneven and all stages of the insect may be found from May until the middle or even the last of November. The average length of time required from egg to adult and the number of broods a year are very difficult to fix because of the great amount of variation and uncertainty due to differences in seasons and the difficulty in determining the same. However, there are from three to many overlapping broods each year.

[1] Sulc, Karel, Acta Soc. Ent. Böhemiæ, VI, pt. 4, pp. 105–108, 1909.

Distribution

As previously stated, this insect has a wide distribution in California. It has been taken in great numbers in Alameda County and received from Eldorado County by the writer and has been reported by others from Los Angeles, Inyo (Death Valley and Argus Mountains), Imperial and San Luis Obispo Counties in California and also from the states of Colorado, Utah, Arizona and New Mexico.

Food Plants

The food plants are only imperfectly known and include in California, the following: Alfalfa (Imperial County), tomatoes (San Luis Obispo County), spruce (Los Angeles County), *Pinus monophylla* Torr. (Argus Mountains, Inyo County) as reported by Crawford, and on the following plants on the campus of the University of California, Berkeley Alameda County, by the writer: tobacco, petunia, *Solanum marginatum* Linn., S. *verbascifolium* Banks, *Datura sanguinea* R. & P., and *Iochroma tubulosa* Benth. It was also received from Placerville, Eldorado County, where it was abundant on potatoes. In Colorado it was first taken on cultivated pepper and later on tomato and common nightshade (*Solanum nigrum* Linn.). In Arizona Crawford lists it on arborvitæ and *Pursia* sp.

Control

Though unprotected and comparatively delicate, this insect is not at all easy to control. At least two factors enter into this: its fondness for the undersides of the older leaves near the ground where it is well protected from sprays, and the delicate nature of the food plants which will not permit the use of a strong spray of any kind. The first factor can only be overcome by very great care in applying the remedy and the second by the use of tested materials. The oil and soap sprays are specially to be avoided as they seem to be particularly destructive to solanaceous plants and are not recommended unless used in very diluted proportions and then only after experimenting on a few plants. Nicotine sulphate or black leaf forty may be used with comparative safety at the rate of from 1 to 1,000 to 1 to 1,500. Prof. C. P. Gillette writes that in Colorado, several remedies have been studied, especially on tomatoes, and only lime-sulphur proved successful. The commercial product was used in the proportions of 1 to 40 and killed the psyllids without serious injury to the plants. A spray of about the same strength has been used experimentally in spraying potatoes for fungous diseases, but proved to be positively harmful to the crop.[1]

[1] Stewart, F. C. and French, G. T., Bul. No. 347, N. Y. Agrcl. Exp. Sta., pp. 79, 81, March, 1912.

All experiments with lime-sulphur should be first tested on a small scale before extensive applications are made. Fortunately, the insect in question seldom if ever deserves control measures in this state.

Bibliography and Synonymy

Sulc, Acta Soc. Entom. Bohemiæ, VI, pt. 4, pp. 102–108, 1909, *Trioza* (Original description and 1 plate).

Crawford, Pomona Jr. Entom. III, No. 1, pp. 446, 448–450, Feb. 1911 (2 figures).

Johnson, Colo. Agrcl. Exp. Sta. News Notes, 1911 (Tomato psyllid).

Patch, Bul. 202, Maine Agrcl. Exp. Sta., pp. 231–232, 1912 (2 figures).

Crawford, Bul. 85, U. S. Nat. Mus., pp. 71–72, 1914 (6 figures).

Paratrioza ocellata Crawford, Pomona Jr. Entom. II, No. 2, p. 229, May 1910; also Pomona Jr. Entom. III, No. 1, pp. 447–448, Feb. 1911 (5 figures).

Paratrioza pulchella Crawford, Pomona Jr. Entom. II, No. 2, p. 229, May 1910; also Pomona Jr. Entom. III, No. 1, p. 447, Feb. 1911 (Synonym of *Paratrioza ocellata* Crawf.).

The Laurel Psyllid

Trioza alacris Flor

(Plate 20, figs. 3, 4 and fig. 23)

The laurel psyllid has been the cause of considerable loss to nurserymen in the San Francisco Bay region and has received the attention of local authorities since 1911 when it was first discovered. It was evidently imported from Europe where it has been known as a pest for many years. As an enemy of the laurel it is very pernicious and not only disfigures the foliage, but causes smutting and greatly stunts the plants. Its presence means continued and expensive control measures or very unsightly trees if nothing is done. As the laurel is a favorite ornamental tree and grown generally throughout the state, anything that tends to make it less beautiful should be known and its further dissemination avoided.

Though the known distribution[1] is limited it cannot be long confined to its present areas. Local horticultural authorities are endeavoring to prevent its spread and they are doing much in this direction, but there must be more than local action to make a safe guarantee to the rest of the state. It is sincerely hoped that the few small infestations might be entirely stamped out while this is still possible, before they become too large.

[1] Since preparing this description the author has received specimens of the adults, nymphs and work of this insect on *Laurus nobilis* from Dr. A. G. Smith of Pasadena, California. This is the first record from the southern part of the state and indicates the possible establishment elsewhere in the state.

Sept. 29, 1916.

General Appearance

Eggs (Fig. 23 D).—The eggs are very pale yellow or transparently-white with a darker yellow or orange-colored area near the tip. The entire surface is covered with a very fine whitish powder which gives a grayish color. The shape is elongate-oval with a pointed base and short stipe which is attached to the leaves and a broadly rounded top. The length averages about 0.07 mm.

Nymphs (Pl. 20, fig. 4 and fig. 23).—The nymphs are pale yellow or partially orange-colored and are covered with a thick white cottony wax which is unevenly arranged and entirely hides the body. The naked bodies are rather slender and only about 2 mm. long while with the covering they appear decidedly wide and from 3 to 4 mm. long. When ready to emerge as adults the nymphs leave the galls, which are made at the edges of the leaves and which afford very good protection, and crawl out on the flat surfaces of the leaves where the old skins are left behind. These cast skins are commonly mistaken for the living forms. The bodies are covered with simple and spear-shaped spines (Fig. 23 C).

Adults (Pl. 20, fig. 4 and fig. 23).—The adults greatly resemble those of the tomato psyllid in general aspects. The bodies are pale amber with darker brownish or nearly black markings, as shown in the accompanying drawing (Fig. 23). On many of the individuals there is a noticeable narrow white line across the dorsal base of the abdomen; while in others this line is entirely absent. The legs and antennæ are pale yellow, with the last two joints of the antennæ black (Fig. 23 A, J). The length of the body averages about 2 mm.

Technical Description

Crawford gives the following technical description of the adults:

Length of body 1.9 mm.; length of forewing 3.2; width of head 0.71. General color greenish yellow to light brown; dorsum in darker individuals more or less striped and streaked with brown; abdomen often brown; antennæ black at tip.

Head nearly as broad as thorax, not strongly deflexed; vertex more than half as long as broad, emarginate in front at median line, with a prominent sulcate impression on each side of median line and parallel to it; genal cones scarcely two thirds as long as vertex, divergent, subacute, not much depressed from plane of vertex. Antennæ about one and a third times width of head, slender.

Thorax not broad, well arched, punctate; pronotum moderately long, not strongly depressed; præscutum rather large. Legs slender; hind tibiæ with two black spines at apex on inside and one outside. Wings long, slender, transparent, fully three times as long as broad, subacute at apex; Rs short.

Genitalia.—Male.—Anal valve a little longer than forceps, hind margin arcuate, with long pubescence; forceps rather stout, sides almost parallel (from side), terminating in a subacute, black point at apex. *Female.*—Genital segment nearly as long as rest of abdomen, acute at apex, valves subequal in length.[1]

[1] Crawford, D. L., Bul. 85, U. S. Nat. Mus., pp. 94–95, 1914.

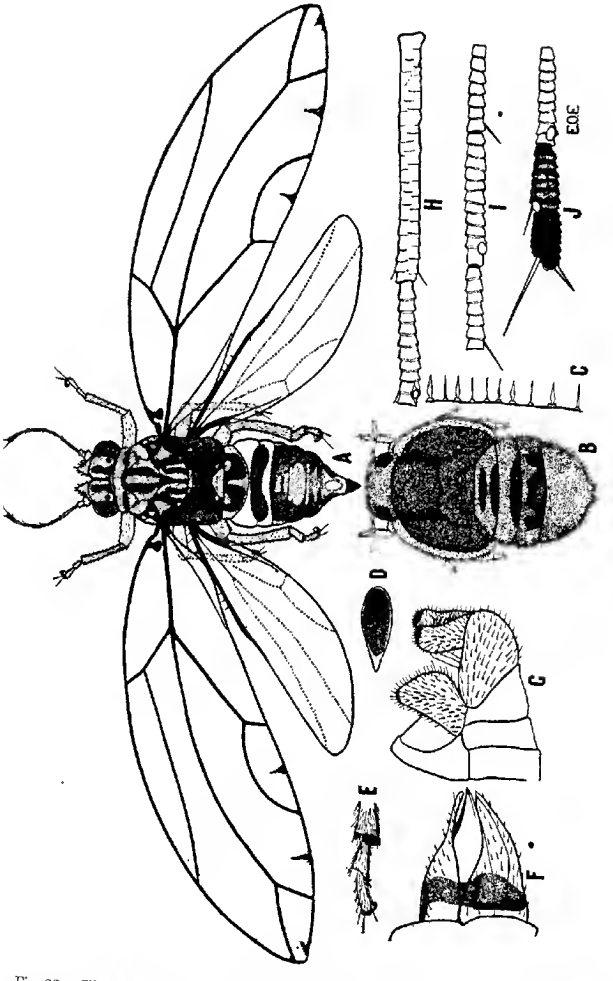


Fig. 23.—The laurel psyllid, *Trioza alacris* Flor. *A*, adult female with wings spread; *B*, nymph with cottony covering removed to show the body; *C*, simple and spear-shaped spines which cover the body of the nymph (greatly enlarged); *D*, egg; *E*, tip of tibia showing apical spines; *F*, genitalia of female; *G*, genitalia of male; *H*, third and fourth joints of the antenna; *I*, fifth, sixth and seventh joints of the antenna; *J*, eighth, ninth and tenth joints of the antenna. All much enlarged. (Original).

Life-History

The winter is passed in the adult stage in a more or less active condition upon the food plants or upon the plants in the near vicinity. In March and April the eggs are laid in few or great numbers on the very small leaves of the tender shoots. The young nymphs feed at the edges of the leaves, causing a decided curling and thickening of those places (Fig. 3) and producing quite a definite leaf-gall. The galls enlarge with the leaves and are at first of the same color, but gradually become lighter and later bright reddish and eventually brown or black. As previously stated, the nymphs usually remain within the galls until maturity is reached when the latter are deserted and often become the abode of other insects, especially mealy bugs (*Pseudococcus* spp.). There are several broods a year, the last one maturing in October and November. Two broods are reported in Europe.[1]

Distribution

The first specimens of this insect were collected in Oakland, Alameda County, and in San Mateo County by Mr. O. E. Bremner.[2] No other infestations were reported until October 1914 when Mr. C. J. Pearsons, a graduate student at the University of California, found it in a nursery at Niles, Alameda County. These are the only known records for California and the United States. In Europe the insect is quite generally distributed.

Food Plants

The only recorded food plant in this state is the laurel or sweet bay (*Laurus nobilis* Linn.). In Europe the insect attacks, besides the above, the cherry laurel or English laurel (*Prunus laurocerasus* Linn.) and the Canary laurel (*Laurus canariensis* W. & B.). As opportunity is afforded these trees will also probably become infested in California.

Control

The control of this pest is very difficult. Besides being covered with a thick waxy secretion which is resistant to sprays, the nymphs are also protected in the leaf-galls from ordinary control measures. The adults which are present practically the entire year are exceedingly active and fly away as soon as the infested plants are disturbed.

Fumigation readily kills all forms, but it is usually impossible to confine the adults under a tent or get them to a fumigating house. The nymphs and eggs, may however, be effectually killed in this way.

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[1] Sulc, Karel, Sitz. Kön. Böh. Ges. Wiss. Prag, pt. XVI, p. 51, 1912.

[2] Crawford, D. L., Mthly. Bul. Cal. Hort. Com., I, No. 3, p. 86, 1912, and Bul. 85, U. S. Nat. Mus., p. 95, 1914.

During the winter months when the adult stage only persists, the plants may be removed to a fumigating house or tent and fumigated and if immediately removed to a safe distance from all other points they may be kept free from reinfestation and shipped elsewhere if they remain clean after a few months' time.

Spraying with miscible oils and oil emulsions readily kills all stages if repeatedly and thoroughly applied. The manufactured grades of miscible oils and kerosene emulsion, crude oil emulsion, and crude carbolic acid emulsion may be used.[1]

Hand-picking has been resorted to in one nursery, but the results have not been satisfactory because of immediate reinfestation.

To get satisfactory results all infested plants must be segregated and removed from other plants to a perfectly clear place and the treatment applied to all as fast as possible and in a definite direction, beginning at one side or end. If the area is so large that it will require more than a few hours to make the treatment, the plants must be removed elsewhere as fast as treated or else they will become reinfested with the adults before the last ones are reached. This has been the fault of most of the work done so far.

Summary

1. Of some fifty described species only two psyllids may be considered of economic importance in California. They are the tomato psyllid, a native species and the laurel psyllid, imported from Europe.

2. The tomato psyllid is generally distributed throughout the state, and, while it prefers solanaceous food plants, also infests others.

3. The tomato psyllid may be controlled by spraying, but is only occasionally serious enough as a pest to warrant a treatment.

4. The laurel psyllid is a serious enemy of the laurel or sweet bay tree, causing disfigurations of the foliage, smutting and generally stunting the plants.

5. The distribution of the laurel psyllid is limited to a few localities in the San Francisco Bay region.

6. When the laurel psyllid is present it is necessary to employ control measures which consist in spraying or fumigation.

7. The laurel psyllid is of sufficient importance to warrant a con-

[1] For the formulæ and methods of preparing and using the above sprays see:

Woodworth, C. W., Circ. No. 128, Cal. Agrcl. Exp. Sta., pp. 3–5, April, 1915 (This circular may be had by applying to the Director of the Agricultural Experiment Station, Berkeley, Cal.).

Essig, E. O., Inj. Ben. Ins. Cal., 2d ed., Cal. Hort. Com., pp. 465–480, May, 1915 (This publication may be secured from the State Commissioner of Horticulture, Sacramento, Cal.).

siderable outlay in money for its eradication which is now possible because of its limited distribution.

(Berkeley, Cal., Jan. 1, 1916.)

Bibliography and Synonymy

Flor, Bul. Soc. Imp. Nat. Moscou, XXXIV, pp. 380, 386, 393, 398–400, 1861.
Lœw. F., Wien, Ent. Zeit., XXXII, p. 230, 1882.
Ver. Zool. Bot. Ges. Wien, XXXVI, p. 160, 1886.
Ver. Zool. Bot. Ges. Wien, XXXVII, p. 22, 1887.
Ferrari, Ann. Mus. Civ. Genoa (2), VI, 1888.
Puton, Catalogue Caën, 1889.
Kessler, Ber. Ver. Kassel, XXXIX, pp. 19–25, 1892–1893.
Massalongo, Mem. Acad. Agric. Verona (3), LXIX, pp. 39–42, 1893.
Tavares, Annæs Naturæs, VII, 1900.
Trotter and Cecconi, Cecidotheca Italica fasc. III, No. 69, 1901.
Rursaamen, Marcellia, Padova, I, No. 11, pp. 62–63, 1902.
Trotter, Nuovo Giorn. Bot. Ital., Fierenze (2) XX, No. 55, pp. 28–29, 1903.
Tavares, Broteria, Lisboa, IV, pp. 33, 223, 1905.
Marchal et Chateau, Mem. Soc. Hist. Nat., XVIII, p. 268, 1905.
Dickel, Zeit. Wiss. Ins. Biol., I, p. 402, 1905.
Oshanin, Verz. paläarkt. Hemip., II, p. 372, 1907.
Grevillius & Nissen, Arbeit. Rhein-Bauern-Verein fasc. III, No. 68, 1908.
Houard, Zoocecidies des Plantes d'Europe, pp. 437, 438, 1908.
Crawford, Mthly. Bul. Cal. Hort. Com., I, No. 3, pp. 86–87, 1912.
Sulc, Sitz. Kön. Böh. Ges. Wiss. Prag, pt. XVI, pp. 49–52, 1912 (1 plate).
Oshanin, Katal. paläarkt. Hemip., p. 129, 1912.
Crawford, Bul. 85, U. S. Nat. Mus., pp. 94–95, 1915 (2 figures).
Essig, Inj. & Ben. Ins. Cal. 2nd. edit., pp. 68–70, 1915 (2 illustrations).
Thomas,[1] Gartenflora, XC, pts. 2 & 3.
Bohlin,[1] Ent. Tidskr., XXII, pp. 81–92 (1 figure).
Hieronymus,[1] Pax, Herbarium Cecidologicum fasc. VIII, No. 231.
Trioza lauri Targioni-Tozetti, Resocont. Soc. Ent. Ital., p. 19, 1879.

[1] As the dates could not be secured for these references, they are placed at the end.

Explanation of Plate 20

Fig. 1.—The tomato psyllid, *Paratrioza cockerelli* Sulc. Nymphs and their white pellet-like excrement on the underside of a tobacco leaf. Enlarged two and one half times. (Original. Photo by Dept. of Scientific Illustration, Cal. Agrcl. Exp. Sta.).

Fig. 3.—The laurel psyllid, *Trioza alacris* Flor. Leaf-galls on young shoot of laurel tree caused by the nymphs. The white cottony masses are the old skins of the nymphs. Natural size. (Author's illustration, Inj. Ben. Ins. Cal. 2nd. ed., 1914).

Fig. 4.—The laurel psyllid, *Trioza alacris* Flor. Adults, nymphs and the cast skins of the latter on a leaf of the laurel tree. Enlarged 6 times. (Author's illustration, Inj. Ben. Ins. Cal. 2nd. ed., 1914).

3

4

Tomato Psyllid

Scientific Notes

The **Pink cornworm** (*Batrachedra rileyi* Wals.) has been discovered in injurious numbers in corn in several localities in Mississippi, and in less numbers in Louisiana and adjacent states.

Wanted: Coccinellid Parasites. A study is being made of *Epomphaloides minutus* How., a chalcidid parasite of Coccinellids, which so far has been reared by the writer only from species of the genus *Coccinella*. If field men will send definite records of the occurence of this parasite, or any other chalcidid parasites of Coccinellids, together with the name of the host, such information will be greatly appreciated. Parasitized material (the chalcidid parasitizes the larvæ and pupæ of the Coccinellids), or reared specimens of the parasites, in case these have not been determined, are also desired. Address: E. J. Newcomer, General Delivery, Portland, Oregon.

Studying the Eggs of Hemiptera. The older entomologists will recall the work undertaken by the late Mr. Otto Heidemann, relating to the study of the eggs of Hemiptera, which resulted in the admirable paper published by him in 1911. Since then practically nothing has been added to the knowledge of this subject. It is now proposed to take up and continue with this important phase of insect life where Mr. Heidemann left off. The attention of field men associated with the Bureau as well as other entomologists is called to this project in hopes that whenever the opportunity occurs they will send in the eggs of Hemiptera for study and description, Any material will he greatly appreciated, and should be addressed to Edmund H. Gibson, Division of Insects, U. S. National Museum, Washington, D. C.

Further Notes on Preservation of Insect Collections. In the December number of the *Monthly Letter* of the Bureau of Entomology appeared an interesting note from Mr. T. S. Wilson concerning the protection of the insect collections. At this station we have adopted Mr. T. S. Wilson's suggestion of melting naphthalene and pouring it into the lids of Schmidt boxes, finding it much more practicable than the use of naphthalene cones which frequently "go adrift" and do much damage to pinned specimens. At this Station we use for storage purposes great numbers of cigar boxes, and we find that the best method of preventing the ingress of any "museum pests" is to brush melted paraffin about corners and edges of hoxes used for such purposes. We have successfully stored large quantities of entomological material and find that after fastening down the lid with a tack that the melted paraffin brushed about the corners of the boxes successfully protects tbe material.

WM. B. TURNER, *Hagerstown (Md.) Field Station.* Feb. 10, 1917.

Clover Leaf Weevil. The JOURNAL OF ECONOMIC ENTOMOLOGY for August, 1916' contained "Notes on the Distribution of the Clover-leaf Weevil (*Hypera punctata* Fab.) in Kansas" by Mr. James W. McColloch of the Kansas Agricultural Experiment Station. The writer can add that this species also occurs at Wellington, Kansas.

While carrying on an investigation of a certain insect in Wellington, Kansas, on July 30, 1915, the writer killed several toads to see if the insect under investigation constituted part of the toad's food. One of the toads' stomachs contained an adult (*Hypera punctata* Fab.). The beetle was sent to Washington and determined as this species and the toad was determined by the Biological Survey as *Bufo americanus*. These toads were caught in alfalfa field near Wellington, Kansas.

T. S. WILSON,
Scientific Assistant.

A Directory of Workers in Hemiptera. During February a circular letter and data blank was sent to all entomologists in this country known to be particularly interested in Hemiptera, the object being to get together a directory of workers within the order, listing their projects in hand and past publications. To date more than 30 blanks have returned with detailed data. If any field men connected with the Bureau, or otherwise, are at present engaged in any problem—economic, biologic, or systematic—relative to Hemiptera and have not received a blank to fill in, they will be conferring a favor by sending data under the following headings to Edmund H. Gibson, Divison of Insects, U. S. National Museum, (*a*) Name, (*b*) Address, (*c*) Position and institution affiliated with, (*d*) Character of work, (*e*) Problems in hand or expecting to undertake, (*f*) List of publications.

Monthly Letter, Bureau of Entomology, February, 1917.

The Mediterranean Flour Moth (*Ephestia kuehniella* Zell.). This insect has attracted more attention during 1916 than for several years. It has made its appearance in warehouses and mills where it was not formerly found. The list of localities includes mostly small towns and cities. It is interesting that while formerly when this species was so very abundant, nearly all millers knew the insect as the Mediterranean flour moth, at the present time they refer to it as "weevil," "flies," and infested material is seldom accompanied by other species of insects. One correspondent writes, "We are worried with a fly that lays eggs, apparently these hatch, and a worm gets in all elevators and spouts, causing a web which takes a very little time to fill cups and spouts, causing web in the flour, and interfering with the flow of the mill."

Hymenia perspectalis Hubner, a Greenhouse Pest. My good friend, Mr. William Falconer, the superintendent of the Allegheny Cemetery, Pittsburgh, on January 10, 1917, came to me, bringing with him a number of specimens of *Hymenia perspectalis* Hübner, and several potted plants of *Alternanthera* which showed the ravages of the larvæ of this little moth.

He reports to me that the insect has confined its attentions to the young plants of *Alternanthera*, which is extensively propagated in the green-house for use in the borders of parterres. Its work has been almost ruinous, and, as this is the first time he has ever seen the thing, he was naturally anxious to learn more about it. I have not taken the time to make a search of the recent literature of the subject to ascertain whether it has been recorded as a pest in other places, but simply call attention in these lines to the fact that, if allowed to propagate in green-houses and conservatories, it may do great damage to the above-mentioned plants.

W. J. Holland.

Carnegie Museum, Pittsburgh, January 25, 1917.

The Life-histories of the Cattle Lice. The life-histories of these species have been worked out during this winter. Ten specimens of the short-nosed ox louse (*Hæmatopinus eurysternus*) were placed on a restricted region on the shoulder of a Holstein calf that was less then twenty-four hours old. The white eggs were soon laid. These were observed once each day and the eggs hatched in from seven to eight days after they were laid. These young were removed and placed on another calf and these laid eggs in from fifteen to sixteen days after hatching, making a life-cycle of from twenty-two to twenty-four days. The female of this species lays from thirty-five to fifty eggs each. The life-history was checked on other calves.

The life-history of the long-nosed ox louse (*Hæmatopinus vituli* Linn.) was very similar though it was slightly longer. The method used was the same as in the previously mentioned louse. These insects were placed in a white patch where the shining black eggs hatched in from eight to nine days and the lice again laid eggs in from

seventeen to eighteen days after hatching, making a life-cycle of from twenty-five to twenty-seven days.

The little red biting lice (*Trichodectes scalaris* Nitz) have been much harder to determine owing to the difficulty in keeping them confined. From the writer's observations supplemented by the hatching of eggs in an electric incubator it is believed that they hatch from the eggs in from five to six days and mature in two weeks though more work must be done on this species to determine its life-cycle with the accuracy of the two previously mentioned species. This would indicate that a treatment might be repeated with the best results from ten days to two weeks after the first treatment.

The experimental work on the control measures will appear in the future in a bulletin from the Storrs Experiment Station.

G. H. Lamson, Jr.,
Storrs, Conn.

An Infestation of Lasius niger L. var. americana with Laboulbenia formicarum Thaxter. On April 7 the writer collected a number of ants of the species *Lasius niger* L. var. *americana*. Upon close examination under a binocular microscope fungus growths were observed on the ants. The fungus occurred particularly on the posterior part of the head, the dorsal surface of the abdomen, and the femora and tibiæ. Every worker examined from one colony was affected, some having more hyphal outgrowths than others. The fungus was identified by Professor R. F. Griggs of Ohio State University as *Laboulbenia formicarum* Thaxter. The fungus apparently had no injurious effects upon the ants, which were as lively as those not parasitized, and the organism is of interest because of its rareness rather than through its effect upon the host. The writer examined the ants of several adjoining colonies but found the individuals of only one other colony infested. This colony was about fifteen feet from the original colony and may have been connected with the former by means of subterranean galleries. Dr. Thaxter of Harvard University has made an interesting study of this and other Laboulbenia, all of which affect insects exclusively.

M. R. Smith,
Department of Entomology and Zoölogy, Ohio State University.

Credit to Whom Credit is Due. On a recent visit to the Bureau of Entomology, through the courtesy of Dr. L. O. Howard the following facts were ascertained:

The anonymous person mentioned by C. V. Riley in his article on the Ox Bot of the United States 1892, was Mr. F. G. Schaupp of Shovel Mount, Texas, a special field agent of the U. S. Department of Agriculture. Dr. Howard kindly showed me a number of letters from Mr. Schaupp dated March, 1892, proving conclusively that he was the experimentor and that Riley merely recorded his observations. The anonymity of that time was on account of personal matters relating to Mr. Schaupp. The principal reason for my writing this note is on account of a somewhat severe criticism I made of the late Professor Riley in Parasitology, 1915, saying that his records were not his own, and also to give credit to Mr. Schaupp for his excellent and valuable experiments on the life-history of *H. lineatum*. Seeing that Professor Riley is dead and that Mr. Schaupp was buried at San Antonio on November 10, 1903, there seems to be no further necessity for keeping his name secret. Mr. Schaupp was the first president of the Brooklyn Entomological Society and is well known for his work in Entomology, especially on the Coleoptera. In conclusion it might be mentioned that Mr. Schaupp was the first discoverer of the eggs of *H. lineatum* and that he also made some valuable notes on the method of oviposition; therefore I think that in future his name should be mentioned in all articles relating to past experiments on Warble-flies.

Seymour Hadwen,
Agassiz, B. C.

Megastigmus aculeatus Swed., Introduced into New Jersey from Japan. (Hymen.) At different times during the past few years, rose growers have complained somewhat, of the failure of Japanese *Rosa multiflora* seeds to germinate. Upon collecting samples of the seeds and keeping them under observation, it was found that they were heavily infested by a member of the *Torymidæ*, which was later identified by Mr. Girault through the courtesy of Dr. L. O. Howard as *Megastigmus aculeatus* Swed. The larvæ of this genus are known to live in the seeds of plants and C. R. Crosby in "A Revision of the North American Species of Megastigmus" (An. Ent. Soc. Amer., vol. 6, No. 2, pp. 155–170, June, 1913) states that this species was reared from rose seeds at Ithaca, N. Y., and that in the collection of the U. S. National Museum, there is a series of specimens reared from rose seeds imported from Peking, China. He also reared specimens from rose hips received from Germany. In order to determine definitely if the species was being imported into New Jersey from Japan, samples of *Rosa multiflora* seeds were taken from nearly every shipment consigned to the State during the spring of 1917. After keeping them nearly fifty days, parasites emerged from all of them about the latter part of May. The larva appears to destroy the entire interior of the seed leaving nothing but the hard outer covering.

HARRY B. WEISS,
New Brunswick, N. J.

Migration of Danaus archippus. Miss Joanna Carey writes from La Junta, Colorado, that on April 26 a "cloud of butterflies" arrived at that place, at about 5.30 in the evening. They seemed to be carried before a very hard wind which was blowing from the east or northeast. Great numbers were to be seen later on the grass, trees and sidewalks. Two specimens sent are both males.

T. D. A. COCKERELL.

A Correction. Line 25, page 260, vol. 10, No. 2, Journal of Economic Entomology, should read "larvæ of the three probable parasites" instead of "larvae of the three parasites probably."

WM. P. HAYES.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1917

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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Applied or practical entomology is so obviously that phase of entomology which is useful or of immediate value that further definition appears unnecessary. Numerous efforts being made to conserve and increase the food supply and natural resources of the nation lead us to question seriously whether our entomology is sufficiently practical to measure up to the present needs of the day. There have been during the last few months various efforts to bring the practical applications of entomology more closely home to the fruit grower and the farmer. The letter, the circular, and the printed sheet have been used freely, and yet it is probable that some of the most effective work has been accomplished through county or other local agents with more or less of an official standing. The county agent has served as both the eye and the interpreter for the entomologist, reporting upon developments in the field, and personally explaining and supervising preventive and control measures. The right man in the field can undoubtedly accomplish much in bringing about a better handling of the insect problem, since most farmers are much more favorably inclined toward a tactful discussion and demonstration than a more or less lengthy letter or bulletin giving directions for procedure.

The value of this work must depend in large measure upon the possibility of anticipating insect injury. The first year under such a system cannot begin to be as successful as later ones because it is very difficult, in fact almost impossible, to anticipate local developments without some previous experience. Moreover, the significant features,

entomologically speaking, of one season differ from those of another, and it is only through careful study extending over a series of years that the scientist and the field worker can coöperate in a highly efficient method of reporting and disseminating information, involving, as this does, discrimination between the vital and the comparatively unimportant, and the forecasting of developments. The present season has demonstrated more fully, perhaps, than any other during the last twenty-five years the profound influence which seasonal conditions may have upon certain insects. These modifications can be forecast in only a general way and are bound to be changed within comparatively narrow limits by local variations.

Current Notes

Conducted by the Associate Editor

Mr. Frederick Knab has been elected a fellow of the Entomological Society of America.

Miss Ina L. Hawes, S. B. Simmons College, 1917, has been appointed assistant in the library of the Bureau of Entomology.

Mr. E. C. Cotton, Elyria, Ohio, has been appointed Chief of the Bureau of Horticulture of the Ohio Department of Agriculture.

On June 5, Dr. A. L. Quaintance and Mr. E. H. Siegler of the Bureau of Entomology visited the Connecticut Agricultural Experiment Station, New Haven, Conn.

The Bureau of Entomology has received word that the Zoölogical Record, Regent's Park, London, N. W., England, has temporarily suspended publication, owing to the war.

Mr. Arthur Gibson, Assistant Dominion Entomologist of Canada, and Mr. E. M. Schalck, Assistant to the State Entomologist of Illinois, recently visited the West Lafayette, Ind., Field Station of the Bureau of Entomology.

Mr. B. A. Porter, a graduate of the Massachusetts Agricultural College, has been appointed to assist R. A. Cushman in the study of hymenopterous parasites of deciduous fruit insects and will be stationed at Wallingford, Conn.

The last legislature of Connecticut increased the appropriation for general work against insect pests from $8,000 to $12,000, and for gipsy and brown-tail moth suppression work from $21,000 to $40,000 for the next biennium.

According to *Science*, Professor D. L. Crawford of Pomona College, Claremont, Calif., has been appointed Professor of Entomology in the College of Hawaii, Honolulu, H. I., for a period of three years, beginning in September 1917.

On June 6, Dr. L. O. Howard, Washington, D. C., Dr. T. J. Headlee, New Brunswick, N. J., and Dr. W. E. Britton, New Haven, Conn., attended a meeting of the National Malaria Committee at the Hotel Biltmore in New York City.

A new division has recently been created in the Bureau of Animal Industry of U. S. Department of Agriculture, to be known as The Tick Eradication Division, and devoted exclusively to the work of eradicating the cattle fever tick in the South.

Dr. E. A. Back, of the Bureau of Entomology, has been placed in charge of the new section of Stored-Product Insect Investigations, recently organized in the Bureau. He spent June 15–16 visiting the Department of Entomology of the Kansas Experiment Station.

Mr. Louis A. Stearns, graduate of Ohio Wesleyan University and Ohio State University, has been appointed for temporary work on insects as carriers of disease in coöperation with the H. J. Heinz Company and the Bureau of Plant Industry at Madison, Wis.

The section on Deciduous Fruit Insect Investigations of the Bureau of Entomology has recently established a field station in Wallingford, Conn., and will take up the study of the tent caterpillar, the apple maggot, and certain other fruit insects. Mr. E. H. Siegler is in charge.

The following transfers have been made recently in the Bureau of Entomology: G. A. Runner from Southern Field Crop Investigations to Deciduous Fruit Insect Investigations, with headquarters at Sandusky, Ohio; A. B. Champlain, Lyme, Conn. to Falls Church, Va.; E. H. Siegler, Washington, D. C., to Wallingford, Conn.

J. D. Mitchell of the Bureau of Entomology has begun an investigation of two rice insects which have caused very large losses in Matagorda County, Tex. Both species are new as enemies of rice. Together they have destroyed the greater part of forty thousand acres of rice, and threaten to spread extensively during the coming season.

On June 6, W. Dwight Pierce received the degree of Doctor of Philosophy from the George Washington University, Washington, D. C. The title of his thesis was "Comparative Morphology of the Insect Order Strepsiptera." The minors were "The Relation of Insects to Disease," and "The Relation of Climate to Insect Life and Activity."

Dr. A. G. Boving and F. C. Craighead, of the Bureau of Entomology, are very anxious to secure living adults of *Corydalis* for anatomical purposes. It will be appreciated if any one who finds adults of the "Dobson fly" will send them alive (in small tin can) to either Dr. Boving at U. S. National Museum or Mr. Craighead at East Falls Church, Va.

A series of meetings of beekeepers were held early in July at points in Vermont under the supervision of Dr. Burton N. Gates, now a Collaborator of the Bureau of Entomology. A similar series of meetings is being arranged in western Maryland which will be attended by Kenneth Hawkins and G. H. Cale of the Maryland State College of Agriculture, now Collaborator of the Bureau.

According to *Science*, Messrs. George P. Englehardt, Curator of Invertebrates, and Jacob Doll, Curator of Lepidoptera in the Brooklyn Museum, have, through the generosity of Mr. B. Preston Clark of Boston, undertaken an expedition to the plateau regions of southwestern Utah and Northern Arizona, and will give particular attention to lepidoptera, small mammals and reptiles.

One of the salient features of the initial number of the Emergency Entomological Service issued May 1, is covered under the title "Bioclimatic Law as Applied to the Hessian Fly," by A. D. Hopkins, Forest Entomologist, and is the first direct effort in the application of phenological data to insect emergence and crop planting. (Inquiries and suggestions should be addressed to Dr. A. D. Hopkins, Forest Entomologist, Bureau of Entomology.)

Subscriptions are being received from the employees of the U. S. Department of Agriculture for a fund of $1,450 to be used in donating a fully equipped Red Cross ambulance for use in Europe. This gives a very definite means for aiding in the important work of the Red Cross. The ambulance will be known officially as the United States Department of Agriculture Ambulance. Subscriptions should be sent to Mrs. H. S. Bishop of the Bureau of Entomology.

The following have recently been appointed to the Bureau of Entomology: E. L. Sechrist, Fairoaks, Calif., Assistant in Apiculture, Drummond, Va.; G. N. Wolcott, special field assistant, sugar cane insects, Louisiana and Texas; Torbert Stack, Tallulah, La., K. B. McKinney, A. D. Bosley and F. G. Sorrells, Clarksville, Tenn., temporary field assistants; H. J. Hart, Falls City, Neb.; Dr. Burton N. Gates, Amherst, Mass., and G. A. Gale, College Park, Md., Collaborators; Miss M. A. MacNab, Clerk, Falls Church, Va.

Prof. A. C. Burrill resigned last summer from the position of Assistant Entomologist of the Wisconsin Experiment Station and Instructor in Economic Entomology in the Agricultural College to become Entomologist of the Idaho Experiment Station and Assistant Professor in the Zoölogy and Entomology Department of the University of Idaho. This summer Professor Burrill is in charge of the new substation for entomological work, especially clover aphis, at Twin Falls, Idaho, the heart of the irrigated empire of the Snake River plains.

The following were visitors to the Bureau of Entomology during May: Dr. Burton N. Gates, Massachusetts Agricultural College, Amherst, Mass.; A. F. Burgess, In Charge of Moth Work, Melrose Highlands, Mass.; W. M. Mann, of Bussey Institution, Forest Hills, Mass.; Fred Muir, Assistant Entomologist of the Hawaiian Sugar Planters' Experiment Station, Honolulu, Hawaii; D. M. Rogers, Gipsy Moth Investigations, Boston, Mass.; W. F. Fiske, late of the Bureau of Entomology, who has recently returned from the British service in Africa.

Charles Fuller Baker, A. M., Professor of Agronomy, College of Agriculture, University of the Philippines (stationed at Los Banos, Philippine Islands), announces that he is taking a year's leave of absence, and that for this year he has accepted, under temporary appointment, the post of Assistant Director of the Botanical Gardens at Singapore, in charge of experimental work in Tropical Agronomy. After May 12, 1917, and until further notice, all correspondence should be addressed to him, care of Botanical Gardens, Singapore, Straits Settlements.

August Busck, of the Bureau of Entomology, has returned from his trip to Mexico where he made a careful examination of cotton fields on both sides of the Mexican border in the Brownsville-Matamoros region without finding any evidence of the pink bollworm. Neither was any evidence of infestation found in the district opposite Eagle Pass, Tex., but two Mexican plantations near the United States were found on which considerable areas of cotton had been planted with seeds imported from the Laguna district. There is every reason to anticipate, therefore, that in these fields the pink bollworm will develop this year. A very strict watch must be maintained, and whatever remedial steps are possible will be undertaken in coöperation with the Mexican authorities.

Issued August 20, 1917.